Appendix B. Species Associated with the Karner Blue Butterfly and its Habitat

This appendix includes information on species associated with the Karner blue butterfly and its habitat in Wisconsin. It is comprised of two reports that were prepared to support development of the statewide Wisconsin Karner Blue Butterfly HCP:

Kirk, K. 1996. The Karner blue community: Understanding and protecting associated rare species of the barrens. Final Rept. to USFWS (Amendment #38 to Cooperative Agreement #14-16-0003-89-933). Wisconsin Dept. Natural Resources, Madison. (Pages B-3 - B-84)

Borth, R.J. 1997. Karner blue management implications for some associated Lepidoptera of Wisconsin barrens. Unpub. Rept. to HCP partners. Wisconsin Gas, Milwaukee. (Pages B-85 - B-113)

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A. "The Karner Blue Community: Understanding and Protecting Associated Rare Species of the Barrens" by K. Kirk

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Introduction

The barrens habitat of central and northwestern Wisconsin is a diverse community of native plants and animals whose lives are intertwined with each other and the natural elements of sun and shade, wind and rain, fire and drought. Each species has evolved mechanisms to ensure the survival of its kind in the context of the large and small-scale disturbances that are integral to the barrens habitat. For many, disturbance has become a necessity to provide the diversity or specificity of habitat elements required. With the arrival of humans, the cycles of disturbance were altered as was the land itself.

The challenge has become one of provision for the native inhabitants while satisfying the needs and desires of human society. Over one hundred and fifty years of change to the landscape has left a long list of the native species in isolated, reduced populations that are increasingly vulnerable to further losses from reduced genetic diversity and the effects of inbreeding depression, stochastic events, inordinate predation pressures, increased interspecific competition, collecting, and inadvertent destruction by human activities.

Most recently the spotlight has fallen on one animal of the barrens community: the Karner blue butterfly. Extensive research is proceeding to illuminate the biological and ecological needs of the species. Since the Karner blue was listed as federally endangered by the U.S. Fish and Wildlife Service in December, 1992, any human activity which may result in the loss of individual butterflies must be carefully scrutinized. The development of a Habitat Conservation Plan (HCP) to ensure no net loss to the species is required by federal law for all lands with Karner blue habitat. The Wisconsin Department of Natural Resources is meeting this conservation challenge with a holistic approach.

First, the development of a comprehensive plan that integrates conservation practices and economic land use on Wisconsin Karner blue habitat will result in a statewide HCP. This plan will be the first creation of its kind by a partnership of public and private landowners with diverse interests. Secondly, the Wisconsin DNR has committed its resources to manage for biodiversity on state lands that support the Karner blue butterfly and, through the HCP process, to encourage a multi-species approach on private lands as well. Such proactive planning for conservation offers the opportunity to better understand and protect the natural community of flora and fauna in which the Karner blue butterfly is but one of the residents.

In the fall of 1994, a list of 122 rare species associated with dry prairie, barrens, and savanna in Wisconsin was reviewed by experts familiar with the various taxa. Forty-one species from the list were identified as associated with barrens in Karner blue butterfly range. The list of species under consideration was further refined in March, 1995 to those rare species highly associated with barrens habitat in Karner blue butterfly range or those species moderately associated but listed or candidates for listing at either the state or federal level. The sharp-tailed grouse is rather a special case. It is only moderately associated with Karner blue butterfly habitat but is of special

concern in the state and the large areas needed to meet its breeding and population requirements are primarily within Karner blue range.

Twenty-two species and two subspecies are considered in this document. Thirteen are federally or state listed or under consideration for listing. Of the remaining nine, eight species are insects highly associated with the habitat of the Karner blue butterfly and therefore can be expected to be particularly affected by environmental alterations made during management for the Karner blue. The ninth species is the sharp-tailed grouse.

The following accounts will introduce each species and describe the range and habitat, taxonomic affiliations, life history, and management concerns. Briefly, the needs of each species are simple: food, water, reproductive success, freedom from bodily harm, maybe shelter. The plants need pollinators, periodic removal of litter, and gaps in the canopy. Response to disturbance appears to vary for the plants. Turtles need stable water levels for hibernation in winter; sunny, sandy, perhaps previously disturbed upland areas for nesting; and safe passage in the uplands.

Roads are lethal to all the reptiles. The massasaugas spend time basking and foraging in the shrubby upland areas around the wetlands and may suffer mortality from burning or mowing. Forest succession reduces their habitat as it does for the slender glass lizard. The glass lizard needs open, grassy areas with lots of invertebrates and mammal burrows. The lizards however, have poor adaptations to fire and require patches of unburned habitat for survival.

Each kind of bird responds to a different but specific habitat structure: shrubs or low trees within fairly tall grasses for shrikes, large stands of small jack pines for Kirtland's warblers, large open areas with additional shrubby areas, some trees, and wooded wintering areas for sharp-tailed grouse. The lepidopteran species need food plants for both larvae and adults. They need protection for vulnerable life stages and/or opportunity to recover from population losses. The species discussed here vary in tolerance of habitat degradation, habitat specificity, and ability to recover after population losses. Eight of the ten lepidopterans are single-brooded indicating a slow recovery time. The phlox moth appears to hibernate in the soil and the frosted elfin may be underground in the winter as well, but the other species hibernate in the leaf litter or within the host plant where the immature animals are vulnerable to winter disturbance. The red-tailed leafhopper requires undisturbed patches of prairie dropseed. Tiger beetles require open patches of sand with abundant insect prey and are most vulnerable in the egg stage to habitat disturbance or degradation.

The land management activities undertaken in barrens habitat where Karner blue butterflies reside and timber is harvested will be moderated by the characteristics of the individual sites involved. Burn management, clearcuts, mowing, and various degrees of soil disturbance each have their places in the complex of the landscape where microhabitats coexist with silviculture. Some sites overlapping in space and time can be managed to provide the needs for the natural

community while timber harvest and recreational activities are taken into account. Other sites will not so easily bend to diverse demands.

Close scrutiny of the information included herein will reveal not so much a bewildering array of hopelessly opposing considerations but patterns of nature. These species are but twenty-two snapshots of the life embellishing ‘barren’ land. Threads of the pattern appear in considering how each of the species manage to survive winter, adapt to a landscape ravaged by wildfire, minimize competition with similar animals for necessary resources, and opportunistically maximize the survival of their kind with the ‘help’ of other species without destroying those neighbors.

RARE SPECIES ASSOCIATED WITH KARNER BLUE BUTTERFLY HABITAT THAT ARE DISCUSSED IN THIS DOCUMENT

State or Federally Listed Species or Candidates for Listing

Species	Common Name	Status-St.	Status-Fed.
Talinum rugospermum	prairie fameflower	SC	C2
Asclepias ovalifolia	oval-leaved milkweed	PTHR	none
Viola fimbriatula	sand violet	END	none
Aflexia rubranura	red-tailed pr. leafhopper	SC	C2
Schinia indiana	phlox moth	END	C2
Incisalia irus	frosted elfin	THR	none
Phyciodes batesii	tawny crescent	SC	C2
Clemmys insculpta	wood turtle	THR	none
Emydoidea blandingi	Blanding's turtle	THR	C2
Ophisaurus attenuatus	W. slender glass lizard	END	none
Sistrurus c. catenatus	eastern massasauga	END	C2
Lanius ludovicianus	loggerhead shrike	END	C2
Dendroica kirtlandii	Kirtland's warbler	SC	END

Species with High Karner Blue Butterfly Habitat Association

Species	Common Name	Status-St.	Status-Fed.
Incisalia henrici	Henry's elfin	SC	none
Chlosyne gorgone	Gorgone checkerspot	SC	none
Erynnis martialis	mottled dusky wing	SC	none
Erynnis persius	Persius dusky wing	SC	none
Hesperia leonardus	Leonard's skipper	SC	none
Hesperia metea	cobweb skipper	SC	none
Atrytonopsis hianna	dusted skipper	SC	none
Cicindela p. patruela	tiger beetle	SC	none
C. patruela huberi	tiger beetle	SC	none
Pedioecetes phasianellus	sharp-tailed grouse	SC	none

END=State Endangered; THR=State Threatened; PTHR=Proposed State Threatened (1995); SC=State Special Concern; C2=Federal Category 2 (candidate, under review for listing)

Rough-Seeded Fameflower (*Talinum rugospermum* Holzinger)

Taxonomy and Status. Fameflowers are succulents in the family Portulacaceae. Two species of fameflower occur in the Midwest. Prairie fameflower, *Talinum parviflorum*, is the more common species and occurs in similar habitats to that of the rare rough-seeded fameflower, *Talinum rugospermum*. Rough-seeded fameflower was long thought to be a Midwestern endemic but recent finds in Kansas, Nebraska, and Texas place it within the flora of the Great Plains from which it spread probably by long distance post-Pleistocene dispersal to become disjunct in the Midwest (Cochrane, 1993). Refer to Gleason and Cronquist (1991) for a description of the species. Rough-seeded fameflower is of special concern in Wisconsin but occurs often enough in the state to be apparently secure. The U.S. Fish and Wildlife Service is reviewing the species as a candidate for listing.

Range. Rough-seeded fameflower is found in Kansas, Nebraska, and Texas, eastern Minnesota and Iowa to northern and central Illinois, southern Wisconsin, and northwestern Indiana. Throughout most of its range it is considered rare and localized.At some Wisconsin stations, the species is quite common. Rough-seeded fameflower has been collected from 95 stations in 23 counties of Wisconsin, primarily in the southwest but collections have also been made in Pepin, Polk, Pierce, and St.Croix counties. Historical records exist from Burnett and Jackson counties (Barloga, et al., 1989). The site in Polk County is very near a jack pine savanna site of the Karner blue butterfly (NHI, 1994). Rough-seeded fameflower is extant in oak barrens of Columbia, Iowa, and Monroe counties (Barloga, 1989).

Habitat. *Talinum rugospermum* inhabits open, exposed sites where there is minimal competition from other species. It occurs on xeric prairies, sand barrens, sandy and rocky outcrops, gravel river terraces, old fields, trail edges, openings in sandy woods, and margins of sand blows. In Minnesota the species is found in a barrens habitat of black oak or jack pine with shifting sand dunes along the Mississippi River (Coffin and Pfanmuller, 1988). In Indiana, and Illinois as well, the species is found in black oak barrens habitat with sand dunes. In Iowa, colonies have been found on sand dunes of the Upper Iowa River, sandy bluffs, and sand blowouts. The Kansas stations are in sand prairie where the plants grow on the sides and tops of dunes and in sparsely-vegetated flat areas (Cochrane, 1993).

Associated species in sand prairie and barrens in Wisconsin are *Andropogon scoparius, Selaginella rupestris, Opuntia compressa*, and *Panicum virgatum*. *S. Rupestris* is a good indicator species for fameflower as are *Allium stellatum, Isanthus brachiatus, Hedyotis longifolia,* and *Ambrosia a88rtemisiifolia* (Judziewicz, 1994). Species that may co-occur as well, on dry prairies of sandstone bedrock or outcrop are *Tephrosia virginiana, Hedeoma hispida*, and *Gnaphalium obtusifolium* (Cochrane, 1993). *Asclepias amplexicaulis*,clasping milkweed, and *Hudsonia tomentosa*, beach heath, occur with rough-seeded fameflower in

Minnesota (Coffin and Pfanmuller, 1988). In Kansas, prairie fameflower, *Talinum parviflorum*,

co-occurs with the rare species.

Talinum rugospermum can also be found on open outcrops of Precambrian metamorphic and igneous rock in Wisconsin. It has been discovered on both basalt and granite where it lives in thin 9soil and is accompanied by brittle prickly pear, *Opuntia fragilis*, a state-threatened species. In the Baraboo hills *T.rugospermum* has been located on a rhyolite outcrop (Cochrane, 1993).

Life History. *Talinum rugospermum* is a rosette-forming perennial with loose cymes of less than a dozen flowers. Each pink flower opens one day only and strictly in the afternoon in July and August. Morning flowers belong to *T. teretifolium* of western Minnesota. Seeds of the species require light to germinate so that a thick layer of litter or shading from a plant such as *Carex pennsylvanica* will discourage germination (Pavlovic, pers.comm.), though seedlings can emerge from a depth of 12mm in sand. The plants grow slowly; a one-year old may have only six small leaves. With age, plants develop multiple stems. Flowers do not appear until the plant is 3-4 years old. Rainfall may be one factor that initiates blooming synchronous with insect activity. Flowers are capable of autogamy late in the blooming period. There is some evidence that *Talinum* spp. can propagate vegetatively from rhizome pieces if sufficient moisture is available (Pavlovic, 1989).

Management Concerns. *Talinum rugospermum* is a specialist with narrow ecological requirements which restrict it to few habitats. It is not an effective colonizer though it is a pioneer of disturbed ground. It does not colonize old fields or roadsides with other prairie species nor is it found in young fields with weedy species (Cochrane, 1993). Rogers found *T.rugospermum* to appear in old fields only after 11 or more years. Not until the field was over 25 years old did the numbers of rough-seeded fameflower equal that found in unplowed prairie (1979).

Talinum rugospermum is dependent on microsite-scale disturbance, such as the natural sand movements of its dune habitat. Plants often colonize anthropogenic disturbance patches. Activities, including vehicular traffic or soil erosion, that create small areas of open habitat benefit the species. This was recently documented in plots disturbed by soil preparation and herbiciding for subsequent planting of lupine when fameflower was found to occur in much higher densities within the plots than without. For some plots with fameflower, no other plants were found outside the plot boundaries (Maxwell and Givnish, 1994).

Some *T.rugospermum* populations have been found in old wheel tracks. Gopher digging can lead to expanded populations (Rogers, 1979). Disturbance of the soil by all-terrain vehicles and tanks has encouraged *T. rugospermum* at Fort McCoy in Wisconsin (Leach, 1993)and resulted in some areas of dense coverage by the species. At Indiana Dunes National Lakeshore, however, continued ATV use has negatively impacted the populations where the plants are too often uprooted (Pavlovic, 1989). Pavlovic has often observed the populations to suffer from heavy trampling (1995). Unfortunately, aggressive or invasive exotic species which compete with *Talinum* are also encouraged by soil disturbance.

The plant is quite shade intolerant and will not survive under canopy conditions although seed germination may occur before leaves unfurl on black oaks (Pavlovic, pers.comm.). The species is a poor competitor against taller herbs and grasses that create shade. Fire, which reduces competition from shrubs and herbaceous species as well as removing litter from the soil surface, appears to benefit the plant populations. At a site in Illinois, the presence of *Talinum rugospermum* increased after wildfire (Cochrane, 1993). Pavlovic has found that the adults are tolerant of fire, though seedlings are more vulnerable (1995). Plants have been observed to be killed by fire, presumable because the buds of next year's growth are at the soil surface (Pavlovic, 1989).

In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the above was drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of botanists most familiar with the species and others of its kind. In this case, research into the response of the species to soil compaction and timing and intensity of fire, and the proximity to soil disturbance of a seed source for colonization would be most valuable to generate further informed land management decisions concerning *Talinum rugospermum*.

Oval Milkweed (*Asclepias ovalifolia* Dec.)

Taxonomy and Status. Milkweeds**,** *Asclepias,* are in the family Asclepiadaceae. The genus *Asclepias* is composed of about 95 species, mostly in the New World. Twelve species occur in Wisconsin and inhabit communities from dry prairie to swamp. Two species are listed Threatened in the state, *A.lanuginosa* and *A.sullivantii*. A third species, *A.purpurascens*, is listed as Endangered in Wisconsin. *Asclepias ovalifolia* is proposed Threatened in Wisconsin. It has no federal status and is moderately associated with barrens habitat. Refer to Gleason and Cronquist (1991) for a description of the species. Sterile stems are difficult to distinguish from stems of the common species, *A. syriaca.*

Range. Oval milkweed ranges from southern Saskatchewan, Manitoba, and the Dakotas to eastern Wisconsin and northern Illinois. Wisconsin state herbaria have specimens from approximately 50 locations in the state where *Asclepias ovalifolia* was collected between 1879 and 1984 (Westad, 1993). A search of 22 historical sites that could be relocated in 1993 by Westad confirmed the species flowering at only six sites with about 500 individuals present at all sites. Those sites are in the counties of Barron, Burnett, Monroe, Oconto, Marinette, and Menominee. Oval milkweed has also been reported from Polk, Jackson, Juneau, Adams, Wood, and Vernon Counties (NHI, 1994; Swengel, 1995).

Habitat. Curtis found *A.ovalifolia* modal in southern dry forest (1959) and did not list the

species in dry prairie or barrens habitat. Noamesi and Iltis (1957) report the species on prairies, sandy roadsides, and woodlands. Westad found oval milkweed in prairies, but almost as often in sandy, open, pine-oak woods (1993). The species has been found at Fort McCoy in a dry forest of jack pine with oak sapling understory (Leach, 1993). The largest population in Wisconsin is in a treeless railroad right-of-way mesic prairie (Westad, pers.comm.).

All of the sites found in 1993 are on level to gently sloping sand to sandy loam soils over deep sand or sand and gravel. The pH ranges from 4.5 to 6.0. Most of the soils have 0.5 to 2.0% organic matter but the site with the largest number of individuals has 8.9% organic matter (Westad, 1993).

Life History. The yellowish or greenish flowers of *A.ovalifolia* are present from early June to mid-July (Noamesi and Iltis, 1957). Like other milkweeds, it is insect-pollinated, probably by species of Diptera (Betz, 1996). Pods harbor mature seeds in October. One collection of wet-stratified seeds had a germination rate of 95% (Westad, 1993).

Management Concerns. Oval milkweed needs gaps in the canopy to create the open environment in which it will thrive. All of the extant populations found in 1993 had received some canopy management, including burning and tree cutting. The railroad right-of-way is open and some other sites are on the edge of woods along roads (Westad, 1993). Leach did not find the species at historic sites at Fort McCoy and observed that white pines were invading the barrens creating a shaded environment for groundcover (1993). Westad did not find the species to be associated with mechanical disturbance although at one site it appears in open areas created by the destruction of woody seedlings by vehicular traffic (1993). In Barron County, however, the species was extirpated from a site that was graded during road leveling (Hoffman, pers.comm.). Like many prairie milkweeds, *Asclepias ovalifolia* probably thrives with management to maintain an open habitat, such as grazing or mowing. Any mowing however, such as is often used along roads and rights-of-way, should be postponed until after seed set in October.

Too small an area of habitat in which the remnant populations are found may not have enough food for insect pollinators, according to Hugh Iltis of the University of Wisconsin Herbarium. In such circumstances the plants may only survive as adults spreading slowly clonally in an area where the pollinators are locally extirpated (Iltis, pers.comm.).

In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the above discussion was drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of botanists most familiar with the species and others of its kind. In this case, research to identify pollinators, best timing and extent of fire management, and the effects of soil disturbance would be most valuable

to generate further informed land management decisions regarding *Asclepias ovalifolia*.

Sand Violet (*Viola fimbriatula* J.E. Smith)

Taxonomy and Status. The family Violaceae is composed of 21 genera but two-thirds of the species are in the genus *Viola*. There are between 550 and 650 species of *Viola* in the world, with the greatest diversity centered in western North America, Mexico, the Andes, southwestern Europe, and Asia (Ballard, 1994). The species are difficult to separate, particularly because they hybridize freely, the hybrids exhibiting intermediate characteristics of the parents. *V. fimbriatula* is known to hybridize with eleven other species of violets (Alverson and Iltis, 1981). Voss relied heavily on experts in writing the Violaceae chapter of Michigan Flora (1985) and it would be wise for anyone wandering into the family to do the same. Harvey E. Ballard, Jr. at the UW-Madison Botany Department is one of the few with expertise in violets. Voss lumps *V. fimbriatula* with *V. sagittata*, considering the Michigan specimens of *V. fimbriatula* as perhaps an environmental variant (1985). It is also known as *Viola sagittata* A.T. *var. ovata* (Nutt.) T. and G. (McKinney, 1992)

Good *V. fimbriatula* specimens are densely hairy and the leaves are never lobed in contrast to *V. sagittata* which may be deeply lobed (Ballard, pers.comm.). However, a suspected individuals should be confirmed by an expert. *V. sagittata* is quite common and modal in oak barrens, according to Curtis (1959). Wisconsin considers three violets in the state of special concern, but *Viola fimbriatula* is listed as state Endangered. It has no federal status.

Range. *Viola fimbriatula* ranges from Nova Scotia, New England, and Quebec to western Michigan, southern Ontario and south to the mountains of Georgia, Alabama, and eastern Tennessee. Russell (1965) has suggested that the violet moved into the North from the Appalachian mountains. The Wisconsin stations are considered disjunct from the main distribution of the species. The one station in Iowa, four in Illinois (McKinney, 1992), and the Wisconsin collections represent the most western extent of the sand violet, suggesting it may have been introduced to the area relatively recently (Alverson and Iltis, 1981). There are four to six annotated specimens in Wisconsin, the first collected in Jackson County in 1947. Single collections are also known from Burnett and Portage Counties (Alverson and Iltis, 1981). One

station is on the line between Jackson and Clark Counties (BER, 1993). McKinney lists a station in Rock County (1992). Although habitat appears to be abundant for the violet at Fort McCoy in Monroe County, it has not been found there (Leach, 1993).

Habitat. Throughout its range the sand violet is found in dry, open woods and clearings, forest edges, and dry fields. The Wisconsin collections are from dry, sandy jack pine-oak woods characteristic of the central sands region of the state. The plant does not tolerate shade and prefers to grow where there is little leaf litter. In Michigan the sand violet is found in sand

prairies and openings in savannas (Ballard, pers.comm.).

Life History. *Viola fimbriatula* is a perennial, arising from prostrate rhizomes. It flowers in the upper Midwest from April through June (Voss, 1985). Most violets are pollinated by butterflies, moths, or bees (Ballard, 1991). Violets have both cleistogamous and chasmogamous flowers, the former being produced later in the season than the petaliferous flowers and continuing through much of the summer. The cleistogamous flowers remain tightly closed and the self-pollination produces seeds more abundantly than do the outcrossed flowers. The three-valved capsules produce seeds in early-to-mid summer. (Ballard, 1992). Violet seeds are known to be dispersed by ants.

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In this case, research into specific pollinators, and the effects of fire and soil disturbance would be most valuable to generate further informed land management decisions regarding *Viola fimbriatula.*

Little is known about the ecology of the sand violet. However, management activities are warranted which maintain an open environment in woods or savanna supporting the violets and avoid degradation of the habitat supporting pollinators and ants. It is likely that disturbance favors the species (Dobberpuhl, pers.comm.). Periodic burning to reduce litter and cool season grasses would appear to benefit the low-growing violets. Although the species is itself a cool-season perennial, early spring burns may not directly injure the populations other than to disrupt flowering for the season as has been observed to be the case for the early prairie species, *Anemone patens* (Eldred, pers.comm.). Mowing and haying, where applicable, may result in the same benefits without loss of spring flowers.

Red-Tailed Leafhopper (*Aflexia rubranura* DeLong)

"Red-veined leafhopper"

Taxonomy and Status. The name, red-veined leafhopper, is a misnomer. The animal does not have red veins, rubra(red)-neura(nerve), but the male has two red spots near the tail as indicated by the scientific name, rubra(red)-nura(tail). Hereafter the species will be referred to as the red-tailed leafhopper per Hamilton (1993).

Cicadellidae is one of three families of Homoptera to be intimately associated with the plants of prairies. The other two families are represented by less than a dozen prairie species while the Cicadellidae have over 700 species across the North American grasslands (Hamilton, 1992). The red-tailed leafhopper was first ascribed to the *Flexamia* genus, a group of grass-feeding Cicadellidae. These leafhoppers range from southern Canada to the deserts of Mexico. *Aflexia* is a monospecific taxon, represented solely by the red-tailed leafhopper of the upper Midwest which is found only with the perennial grass, prairie dropseed, *Sporobolus heterolepis*. See DeLong (1948) for a description of the species. Leafhoppers however, are notoriously difficult to identify and suspected individuals should be examined by a specialist. *Aflexia rubranura* is under consideration for Endangered status in Wisconsin and a federal Category 2 species, a candidate for listing.

Range. The actual range of *Aflexia rubranura* is unknown. It may be truly rare or lack of collection may exaggerate its rarity. The species was first described in 1935 from wet, blacksoil prairie near Chicago, Illinois where it occurred in large numbers (DeLong, 1935). Since that time, it has been collected from prairie remnants in Manitoba, Wisconsin, Minnesota, and South Dakota. Recent surveys in Minnesota revealed the species in only 8 high quality prairie remnants. In Wisconsin, the species has been discovered recently on sand prairie in Sauk County (Hamilton, 1993), a dolomite ridge in Monroe County (NHI, 1994), and sand prairie in Kenosha County (Panzer, R. pers.comm.). *Aflexia* was recorded from Columbia and Waukesha Counties in the early 1960's (Hamilton, 1993). A survey of over two dozen sites in 1994 produced no further locations for the species (Ballard, H. pers.comm.).

Habitat. Rather than the deep soil prairie habitat where *Aflexia* was first found, the richest sites for leafhoppers around the Great Lakes are sandy areas and alvar grasslands associated with thin soil over limestone outcrop (Hamilton, 1992). The alvar grasslands are wet in spring but become very dry during the summer. On a few islands in Ontario, the red-tailed leafhopper has been found in large numbers where prairie dropseed grows from crevices in alvar plains accompanied by spike rush, *Eleocharis elliptica* (Hamilton, 1993). The presence of *Aflexia* and other prairie endemics on these islands may be evidence that some Ontario prairies are remnants of a periglacial grassland that spread across the continent from the prairies to at least southern Ontario during the ice age. These grasslands were most likely shifting upland openings in spruce forest. The prairie leafhoppers belong to the group of their kind which moved north with the glacial retreat and are currently represented most strongly in the western Canadian grasslands (Hamilton,

1992). In Minnesota, *Aflexia* has been found on dry prairies on moraine or limestone ridges, though a few individuals have been found in large, unburned hay fields (Hamilton, 1993). Ron Panzer (pers.comm.), studying the species in Illinois, has found the leafhoppers at sites with very different characteristics including black soil, gravel, and deep sand soils.

Life History. Leafhoppers are related to cicadas, spittlebugs, and scale insects. Like these other Homoptera, *Aflexia* undergoes gradual metamorphosis in which there is no pupa stage and the nymphs hatch from the eggs resembling the adults. They live in the same habitat as the adults and eat the same foods. As leafhopper nymphs molt and progress toward adulthood they change primarily in size and body proportion until the stage of maturity is reached. Red-tailed leafhoppers are bivoltine in the Midwest (Panzer, pers.comm.). Adults of the first generation are present from mid-June to mid-July and the second generation of adults is present mid-August to mid-September. Females deposit eggs into the grass tissue. Panzer speculates that *Aflexia* eggs and nymphs are probably located higher in the *Sporobolus* plants than are associated leafhoppers whose populations are less reduced by fire (see below). The species spends the winter in the egg stage.

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In this case, research into A, B, and C would be most valuable to generate further informed land management decisions in regard to the red-tailed leafhopper.

Presence of *Aflexia* in its chosen habitat is dependent on both the characteristics of prairie dropseed and the animal itself. In Wisconsin, Curtis considers *Sporobolus heterolepis* a prairie indicator. It is present in dry to mesic prairies and is also found in cedar glades (1959). In Wisconsin, the plant is present across the southern part of the state and up the western edge as far north as Polk County (Fassett, 1951). On a Wisconsin sand prairie, a study of the effects of cultivation and gopher disturbance revealed that prairie dropseed was found only on unplowed prairie sites including those unplowed sites disturbed by gopher activity. The species was not found in old field sites, even those that had not been disturbed for 25 years or more (Rogers, 1979). Curtis observed the plant populations to decrease in response to grazing pressure as well (1959). Groundcover disturbance will affect the leafhopper populations in so far as the exact *Sporobolis* plants that are inhabited by the leafhoppers are destroyed (Hamilton, pers.comm.).

Most leafhoppers do not disperse rapidly or over great distances. The females of many prairie-adapted leafhoppers are often entirely flightless, reducing dispersal capabilities (Hamilton, 1992). The size of the animal in this case is of interest. At less than 4.0 mm in length, *Aflexia* is close to the size of a mature floret of *S. heterolepsis* which has disarticulated from the persistent glumes of the spikelet. *Aflexia* is usually wingless in both sexes though Panzer has found as much as

10% of the females in the spring brood fully winged. These fully-winged forms are probably also flightless. They have been found only in unburned areas and do not appear to invade adjacent burned areas (Panzer, pers.comm). The leafhoppers Hamilton studied were rare on hill prairies, though low hills had some of the largest populations of *Aflexia* that he found (1993).Hamilton found that small sites of less than 0.1 ha had *Aflexia* only if they were alvar sites (1993).

The red-tailed leafhopper is usually accompanied by a more common cicadellid, *Memnonia nr.grandis (Parabolocratus grandis* Shaw) that has flightless females and is common on prairies and alvars. This leafhopper is also a specialist on prairie dropseed (Hamilton, 1993). *Memnonia* appears to be more resistant to fire than is *Aflexia* and has been found to be abundant on repeatedly burned sites where it seems to recover from fire in one generation (Panzer, pers.comm.).

On a sand prairie in Sauk County, Wisconsin, *Aflexia* and other prairie endemics were found only on a steep slope where prescribed fires were probably cooler and not as close to the ground as in other areas of the site. At a Minnesota prairie wildlife area, the leafhoppers were found only in the unburned areas and not in the areas managed with a 1-2 year fire frequency (Hamilton, 1993). In several fire-managed prairies, *Aflexia* was found confined to sandblows or other areas where the fire presumably had jumped and left refugia (Ballard, H. pers.comm.). *Aflexia* may repopulate from refugia though Panzer reports some survivors even in completely-burned patches (Panzer, pers.comm.). Collection at a number of fire managed sites in recent years have led researchers to suggest that frequent fire management can contribute to a depauperate leafhopper community (Hamilton, 1993). Most leafhoppers, including the red-tailed leafhopper, appear to recover completely from burns within 2-3 years according to Panzer. However, Hamilton suggests four years between burns of the same burn unit to protect population losses of Cicadellids (Hamilton, pers.comm.). Some of the most productive sites where Hamilton searched for leafhoppers are managed by mowing (1993).

Phlox Moth (*Schinia indiana* Smith)

Taxonomy and Status. The phlox moth, *Schinia indiana*, is one of the diurnal *Schinia* species in the family Noctuidae (owlet moths) that occur in Wisconsin. The Noctuidae family has many taxa and includes such illustrious members as the cutworm, the looper moth, and the armyworm. Like most members of the subfamily Heliothidinae in the world, the genus *Schinia* is best represented in arid to semi-arid regions. *Schinia* reaches greatest diversity in North America in the southwestern United States. The phlox moth is not often described though Hardwick (1958) offers a detailed description. Identifi-cation is best learned by field study with one who has experience with the species. Once the moth has been seen however, there is little difficulty in identification as the species is quite distinctive. The phlox moth is a federal Category Two species under review for listing and is listed as Endangered in Wisconsin.

Range. Although the phlox moth was previously reported from Indiana, Illinois, North Carolina, Arkansas, Texas, Nebraska, Wisconsin, Minnesota, and Michigan, only the latter three states currently report populations (Balogh, 1987; Wilsmann, 1990; Rattray, 1994).
In Wisconsin, *Schinia indiana* was first discovered in 1973 in Eau Claire County, 6 miles east of Eau Claire at the Seymour School Forest, and further verified in the same area (Eau Claire Powerline Barrens) in 1986, 1987, 1989, and 1990. In 1991 and 1992, another population was found at Legend Lake in Menominee County where *Phlox pilosa* (downy phlox), larval food plant of the moth, is widespread along roadsides and trails in the barrens.

At Fort McCoy in Monroe County, a *Schinia indiana* pair was released in 1990 along Hwy. 16 when the Eau Claire powerline site population appeared to be in jeopardy from habitat loss. *Schinia indiana* was found at twenty-six sites on Fort McCoy in 1993-1995, some as far as eight miles from the introduction site (Maxwell and Ferge, 1994; Kirk, 1994; Kirk, 1995) nor does a scatter plot of inhabited sites appear to implicate the introduction. All these populations are unlikely to have been derived from the released pair in just 5 generations (Ferge, pers.comm.). Two additional sites were located in Burnett County and five sites in Jackson County in 1994 (Ferge, pers.comm.; Swengel, 1994).

Habitat. The phlox moth inhabits sandy, scrub oak-pine barrens and prairies and is known primarily from these habitats in the Midwest. The phlox moth co-occurs with Karner blue butterflies (*Lycaeides melissa samuelis*) in Wisconsin and Michigan (Balogh, 1987; Haack, 1993). There are two subspecies of downy phlox in Wisconsin. *Phlox pilosa ssp.fulgida* is widespread in Wisconsin below the Tension Zone. *P.p.ssp.pilosa* is rare in Wisconsin, having been collected in only a few scattered counties (Smith and Levin, 1966). *Phlox pilosa ssp.fulgida* occurs in a wide variety of grassland habitats in Wisconsin from low, damp areas to dry, calcareous "goat prairies"; in open, sandy oak savanna, open oak woods, railroad rights-of-way, and jack pine stands. Common associates include *Andropogon scoparius, Heuchera richardsonii, Dodecatheon meadia, Fragaria virginiana, Lithospermum canescens, Rudbeckia hirta, Silphium laciniatum, Krigia biflora,* and *Comandra richardsiana* (Swink and Wilhelm,1979). Although *Phlox pilosa* does not appear to be dependent on soil disturbance, it may occur at great densities along roads and trails where it often spreads in response to disturbance and the moth has been found in these sites as well. In open areas of the jack pine-oak barrens community and in damp places below railroad embankments, the plant may be found locally abundant. It also occurs scattered widely but thinly under relatively closed-canopy situations in oak woods in low areas adjacent to roadways or openings. The plant flowers from mid-May to early July in Wisconsin and fruiting occurs from late June to late July.

Life History. In late May adult phlox moths emerge when the downy phlox begins to flower and the moths will often fly up to the third week of June. *S.indiana* is one of a number of *Schinia* species including the leadplant flower moth, *S.lucens*, also in our area, that exhibit a remarkable resemblance in coloration to the flowers of their larval food plants. Hardwick (1958) reports that those diurnal noctuid moths that show the highest degree of protective coloration have the most

sedentary habits. However, the fact that *S.indiana* is rarely observed flying is probably more a result of the rapid flight of its kind than is its sedentary nature. The species is best observed on cloudy or drizzly days when resting on or in the blossoms of *Phlox pilosa*. The dusted skipper (*Atrytonopsis hianna*) has been observed nectaring on the same blossoms with *Schinia indiana* (Balogh, 1987).

The species in univoltine. Eggs are laid on the inner surface of the flower sepals next to the corolla tube or sometimes between buds. Like others of its relatives, *Schinia* larvae feed on the flowers and fruit of the host plant. The larvae will feed temporarily on the bud if the flower is still closed but soon heads for the developing seeds. The larva tunnels into the seed capsule and seals itself inside to develop further. Mature larvae will cut the stem below the seed capsule and have been observed on the stem below the cut (Hardwick, 1958). Pupation occurs within 27-35 days of oviposition, apparently in the soil (Schweitzer, 1994; Maxwell and Ferge, 1994).

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In this case, research into dispersal ability, depth of hibernation, and response of the species to fire management during the larval period would be most valuable to generate further data to inform land management decisions in regard to the phlox moth.

Fire has historically played a part in the maintenance of the prairie and barrens communities in which the phlox moth is found. Downy phlox is known to inhabit recently burned jack pine stands (Smith and Levin, 1966). The moth is much less common than is the food plant, though it has been found in both prairies and barrens. *S.indiana* is thought to be underground during the period August through April when prescribed burns are often used to maintain open habitat. Fire in late spring however, can injure or destroy the plants present as well as killing eggs and larvae. If fire management is used in areas supporting the phlox moth, burns on no less than a 4-5 year rotation with no more than 20-25 percent of the area burned in one year are considered by some lepidopterists to be the minimum strategy which may offer the least threat for rare lepidoptera (Swengel,1991; Maxwell and Ferge,1994).

Several of the phlox moth locations in Wisconsin are rights-of-way where roadside mowing may be safely undertaken in August when presumably the species is underground (Maxwell and Ferge, 1994). Depth of hibernation is unknown for this species, so effects of soil disturbance or fire management during the period August through April cannot be ascertained at this time. Schweitzer considers the underground pupae in the East invulnerable to fire (1994). Prior to August, the species may be susceptible to insecticides sprayed during the larval period (Haack, 1993).

A highly-fragmented landscape often leads to local population extinctions when animals are unable to disperse between small habitat patches. Tree planting removes open areas and creates barriers in the barrens community. Tree planting has been implicated as a factor in habitat loss for the phlox moth (Schweitzer, 1989). Management to maintain openings and edges is most conducive to downy phlox though it is uncertain as to how this management will impact the moth.

Frosted Elfin (*Incisalia irus* (Godart))

Taxonomy and Status. The large butterfly family, Lycaenidae, is composed of numerous tribes. The elfins and hairstreaks form a tribe that is most diverse in the American tropics with about 75 species in North America. The frosted elfin, *Incisalia irus*, is one of five species of *Incisalia* that occur in Wisconsin. A sixth species, the western pine elfin, may have recently entered the state on trees brought from the west. It is possible that *Incisalia irus* is actually two species based on morphological differences and larval food plants (*Lupinus perennis* or *Baptisia* sp.) (Schweitzer, 1994b). The frosted elfin may be difficult to distinquish from other *Incisalia* spp., particularly *Incisalia henrici*, but it associates strongly with wild lupine, the same food plant as that of the Karner blue butterfly. Refer to Opler and Krizek (1984) for a description of the species or Bureau of Endangered Resources for materials and photos to separate similar elfins. The frosted elfin currently has no federal status but is listed as Threatened in Michigan where the lupine-feeding form is most abundant. The species is listed as Threatened in Wisconsin as well.

Range. The frosted elfin ranges from southern Maine across the north to below Lake Michigan and into Wisconsin's central barrens, south along the Atlantic coast and Appalachians to Alabama and Georgia with isolated populations of *I.i.ssp.hadros* in Louisiana, Arkansas, and Texas.

Ebner was not aware of the frosted elfin in Wisconsin when he wrote "Butterflies of Wisconsin" in 1970, as the species was not collected here until 1977. Kuehn (1983) reported the frosted elfin in Adams and Juneau counties and, in recent years, more sites have been discovered in Jackson and Wood counties as well (Swengel, 1994). In spite of repeated attempts to locate the species in the barrens habitat of Burnett County (Swengel, 1994) the butterfly has eluded investigators.

Habitat. The frosted elfin always occurs in localized colonies across its range (Opler and Krizek, 1984) in habitat of woodland edges, old fields, pine-oak scrub or barrens where the larval host plants grow. It is most often found however, in sand, shale, or serpentine barrens. The species is confined to barrens in Pennsylvania (Opler, 1985)and is an associate of Karner blue butterflies in the grassy openings of pine barrens habitat in New York, Massachusetts,and New Hampshire where the vegetation is much the same as in midwestern openings (Schweitzer, 1994).

In Wisconsin the butterfly inhabits the sandy, open woods habitat of jack pine barrens in the

above-mentioned counties, a subset of Karner blue range in the state. Swengel has found the species in patches of high-density lupine in woods openings or within 5-10 feet of canopy cover in a more open landscape (1994). Of the three known lupine-feeding butterflies in Wisconsin, *Lycaeides melissa samuelis, Incisalia irus*, and *Erynnis persius* (Persius dusky wing), the frosted elfin is the most localized and uncommon.

Life History. The larvae of *Incisalia irus* feed only on the flowers and developing pods of wild lupine in Wisconsin but also use yellow wild indigo, *Baptisia tinctoria*, in the eastern part of the range. *B.tinctoria* occurs across southern Michigan in sandy openings (Voss, 1985) and has appeared in Wisconsin but is not native to the state. Blue false indigo (*Baptisia australis*) and rattlebox (*Crotalaria sagittalis*) are also used at times (Opler and Krizek, 1984). It is unknown whether the butterfly might make use of other species of wild indigo that occur in Wisconsin.

The frosted elfin is single-brooded. The flight period in Wisconsin is from early May to early June with the prime flight period between May 15 and May 25 just before peak bloom period of lupine (Swengel, 1994). The flight period may be quite short in the northwestern counties. In the eastern states the flight period stretches from the end of April through June (Opler, 1985) probably because of the use of yellow wild indigo for larval food. The males of the hairstreak tribe perch in the afternoon to await females (Opler and Krizek, 1984). The females oviposit eggs singly on flower buds, usually the calyxes. The larvae hatch in 3-5 days and tunnel into the flowers (Cook, 1906). Pupation occurs in a loose cocoon in litter at the base of the host plant (Cook, 1906; Opler and Krizek, 1984). The species winters over in the pupal stage in litter at the base of the host plant (Opler, 1985; Scott, 1986) or underground (Schweitzer, 1985). Location of pupation in Wisconsin has not been determined.

Management Concerns. In an effort to provide land managers with available information on the possible response of the species to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind.

Like the Karner blue butterfly, this species is believed to have always existed in metapopulations characterized by local extinctions and colonizations within a dynamic landscape (Givnish, et al., 1988). The frosted elfin requires open areas and is averse to flight through woods according to the experience of early observers. The ovipositing female never leaves the open, "refusing to fly through dark spots and turning aside to circle a tree rather than come under its shadow" (Cook, 1906). Little is known about the dispersal abilities of the butterfly, but open corridors would be required for recolonization to proceed. The current thought is that management for Karner blues would be equally appropriate for frosted elfins (Schweitzer, 1990; Packer, 1987). Note however, that in Wisconsin the frosted elfin is more restricted than Karners by habitat requirements, abundance, and management tolerances.

Schweitzer has attributed regional declines in the species to fire suppression (1985). Schweitzer believes it unlikely that frosted elfin populations decrease with fire. In fact he knows of sites frequently burned that support the species. Where the species is known to pupate underground, as in New York and New Hampshire, the frosted elfin survives fires between early July and mid-May (Schweitzer, 1985). The butterflies have been observed on new lupine growth within two weeks of a burn (Schweitzer, 1994).

Observations in Wisconsin however raise doubts about fire management of frosted elfin sites. Swengel has found no frosted elfins in 65 fire-managed areas even though those areas had abundant lupine. Fires in May may be particularly detrimental by altering lupine phenology and flower abundance as well as direct egg mortality (Swengel, 1994). Significantly more butterflies have been found however, in areas burned by wildfire over five years previously (Swengel, 1994). Wildfire areas are surrounded by habitat that has been left unburned for much longer than are fire-managed areas where the entire habitat is burned by units on a rotational basis.

Areas managed with late-season mowing and with only part of the habitat cut each year appear to benefit the species according to Swengel's observations at several rights-of-way sites in Wisconsin (1994). Frosted elfins have been observed in these areas as well as at sites with unintensive timber management with about the same frequency as observations in wildfire areas (Swengel, 1994). In Ohio, a bulldozed firebreak in an oak barrens was found later to support lupine populations. The plants were colonized by frosted elfins the following year (Chapman, etal., 1993).

Henry's Elfin (*Incisalia henrici* (Grote and Robinson))

Taxonomy and Status. The large butterfly family, Lycaenidae, is composed of numerous tribes. The elfins and hairstreaks form a tribe that is most diverse in the American tropics with about 75 species in North America. The Henry's elfin, *Incisalia henrici*, is one of five species of *Incisalia* that occur in Wisconsin. A sixth species, the western pine elfin, may have recently entered the state on trees brought from the west. Swengel reports the butterfly difficult to view because it is easily flushed and flies rapidly (1994). Refer to Opler and Krizek (1984) for a description of the species or contact the Bureau of Endangered Resources for materials and photos to separate similar elfins. Henry's elfin has no federal status but is of special concern in Wisconsin due to extreme rarity making it especially vulnerable to extirpation from the state.

Range. Henry's elfin is considered rare throughout its range which extends along the Atlantic Coast from Nova Scotia to central Florida and westward to Texas, Kansas, and Nebraska. *I.h.ssp.henrici* covers most of the range with *I.h.ssp.margaretae* in southern Georgia and Florida and *I.h.ssp.solatus* in central Texas and New Mexico (Scott, 1986). Henry's elfin also inhabits the Great Lakes states, Quebec and Ontario and across Canada to southeastern Manitoba.

Incisalia henrici is decidedly less abundant in Wisconsin than either the frosted elfin or the Karner blue butterfly. In 7 years Swengel has found only 4 individuals (Swengel, 1994). Henry's elfin was collected in the 1950's from Marinette Co. (Ebner, 1970). In the northeastern portion of Wisconsin collections have also been made in Langlade, Oneida (Kuehn, 1983), Shawano, Waushara (Ferge, 1988), and Outagamie counties (Ferge. 1991). Within Karner Blue butterfly range, Henry's elfins have been reported from Douglas, Chippewa, St.Croix, Juneau (Kuehn, 1983), Jackson (Swengel, 1994), and Burnett counties (Ebner, 1970; Ferge, 1989; Swengel, 1994). The latter two counties are the only areas where the species has been found in Karner blue habitat in recent years.

Habitat. Henry's elfin is highly associated with barrens habitat with acidic, sandy, or rocky soils (Opler and Krizek, 1984) and inhabits openings of jack pine-oak woods in Burnett County, especially in areas with heaths (*Vaccinium* spp.) (Swengel, 1994). Henry's elfin is found in Wisconsin with the frosted elfin (*I.irus)* and on Karner blue butterfly sites. Although the food plant of the larvae has not been positively determined for Wisconsin Henry's elfins, researchers agree that heaths, especially blueberry, are the prime candidates (Ebner, 1970; Ferge, 1989; Swengel, 1994). Blueberry and huckleberry (*Vaccinium* sp.) seem to be larval hosts in diverse areas across the range (Opler and Krizek, 1984). Wild plum (*Prunus americana*) (Ebner, 1970) and maple-leaf viburnum (*Viburnum acerifolium*) (Ferge, 1989), have also been mentioned. Redbud (*Cercis canadensis*) appears to be the primary host farther south (Opler and Krizek, 1984). Ferge found violets (*Viola* spp.), puccoon (*Lithospermum* spp.), and rock cress (*Arabis lyrata*) available at Namekagon Barrens for nectar sources (1989). Wild plum, willow, and hawthorn (*Crataegus* spp.) flowers are used in other states (Opler and Krizek, 1984).

Life History. Adults emerge and fly from mid-to-late May. There is one brood. Oviposition varies depending on the host but eggs are laid most often on flowers and buds. The larvae feed on buds and young leaves of the host plant. Henry's elfin overwinters in the pupal stage most likely in the litter at the base of the host plant (Opler and Krizek, 1984).

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind.

In Burnett County, Ferge has found the species at Namekagon Barrens in openings of jack pine-oak scrub or along the fire lanes at the edge of areas managed with prescribed burns where nectar sources were most abundant (Ferge, 1989). Because of the rarity of this species, little information is available on land management effects on Henry's elfin populations. The dependence of the species on small trees or shrubs signals concern over zealous clearing of woody species by the use of fire, brushing, or thinning in occupied habitat. Early spring fast-moving fires may have little direct effect on the animals by skipping over the pupae in the litter but the subject has not been adequately studied and the rarity of the species leaves little room for in situ experimentation.

Gorgone Checkerspot (*Chlosyne gorgone* Hubner)

Taxonomy and Status. The Nymphalidae are the brush-footed butterflies, so called because of the reduced forelegs used for chemoreception rather than locomotion. The Nymphalidae is a large, diverse family of about 4,500 species divided into nine subfamilies. The subfamily Nymphalinae which includes the fritillaries and anglewings, are the spiny brush-footed butterflies whose mature larvae are covered with stiff branching spines. Of these, the tribe of checkerspots and crescents occurs throughout the Northern Hemisphere. There are seven representatives in Wisconsin: four checkerspots and three crescents. Only the two pearl crescents are common; the tawny crescent (*Phyciodes batesii*) and the gorgone checkerspot (*Chlosyne gorgone*) are of special concern in Wisconsin by virtue of rarity. The gorgone checkerspot appears to be secure across its range and has no federal status. It is considered to be highly associated with barrens. See Opler and Krizek (1984) for a description of the species.

Range. The gorgone checkerspot occurs from Michigan, Minnesota, and the Canadian Prairie provinces southward through the Mississippi River valley, the Great Plains, and the east coast of the Rockies to northern Mexico. Isolated populations occur in the Appalachians and a subspecies, *C.g.ismeria*, occurs in Georgia, Alabama, and South Carolina.

Ebner reported collections from Douglas, Burnett, and Dunn Counties in the western part of

Wisconsin as well as from Shawano, Brown, and even Racine Counties (1970). Kuehn reported the species statewide except in the northcentral area (1983). The Natural Heritage Inventory reports the species in Burnett, Crawford, Dodge, Grant, Iowa, Jackson, Monroe, Sauk, Marquette, Outagamie, and Winnebago Counties (NHI, 1994). In recent years large numbers have been found in Jackson County (Swengel, 1994).

Habitat. *Chlosyne gorgone* inhabits ponderosa pine forests in the Rockies and hardwood forests in the Southeast but is primarily a grassland species across most of its range where it can be found on prairie slopes and ridges as well as grassy areas near streams (Opler and Krizek, 1984). It is not primarily a barrens or savanna species outside Wisconsin and is absent from these habitats east of western Michigan (Schweitzer, 1994). In Wisconsin, the species inhabits both barrens and dry to dry-mesic prairies (Kuehn, 1983; Swengel, 1994). Barrens habitat in Burnett, Monroe, and Jackson Counties support gorgone checkerspots. Swengel has found the species in sites with up to 50% woody cover (Swengel, 1994b). In analysis of abundance of butterflies in barrens, Swengel found no correlation between Karner abundance and gorgone checkerspot abundance at the same site. This suggests that the conditions favoring the larval food plants of each are not complementary (Swengel, 1994).

Life History. Although the species is univoltine in the northern part of its range and may regularly produce several generations to the south and west (Scott, 1986), at the latitude of Wisconsin it usually produces two generations with adult flight periods in May to early June and again in July. There is some evidence for a third brood in Wisconsin (Swengel, 1994). Adults usually rest with wings spread and males patrol near host plants to find females (Scott, 1986). Males perch on hilltops in the western part of range to await females. This behavior is less often observed in the Midwest.

Larval host plants are in the family Asteraceae and the primary genus used is *Helianthus* which, along with *Aster* spp., are most often reported as host plants in Wisconsin (Ebner, 1970; Kuehn, 1983). Swengel has observed western sunflower (*Helianthus occidentalis*) to be common to the gorgone checkerspot sites she has visited (Swengel, 1994). Larvae have been observed on *Ratibida pinnata* in Winnebago County (Ferge, 1991). The eggs are laid in clusters under the leaves of the host and the larvae feed communally on the leaves. The butterflies hibernate as third-stage larvae (Scott, 1986).

Across the range, adult gorgones nectar primarily on yellow flowers (Scott, 1986; Swengel, 1995). The Swengels have observed spring adults taking nectar from orange hawkweed (*Hieracium aurantiacum*), puccoon (*Lithospermum* spp.), and lyre-leaved rock cress (*Arabis lyrata*) with fewer observations on cinquefoil (*Potentilla* spp.) and groundsel (*Senecio* spp.). Summer individuals have been seen nectaring at silky aster, black-eyed susan (*Rudbeckia hirta*), orange hawkweed, and western sunflower (Kons, 1990; Swengel, 1994). In Illinois, researchers report sunflowers, asters, and milkweeds as nectar sources (Hess and Sedman, 1994).

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In this case, research into larval location, dispersal ability, and response to fire management and timber harvest would be most valuable to generate further informed land management decisions in regard to gorgone checkerspots.

Location of the hibernating larvae is unknown. Thus, the larvae may be vulnerable to early spring burns or winter timber harvest. Fire after mid-May threatens eggs and larvae on the leaves of host plants. If hibernating larvae are in the leaf litter or soil, fall mowing would avoid killing the insects. Any management with concern for this species must be careful to maintain Asteraceae for food plants of both larvae and adults.

Tawny Crescent (*Phyciodes batesii* Reakirt)

Taxonomy and Status. The Nymphalidae are the brush-footed butterflies, so called because of the reduced forelegs used for chemoreception rather than locomotion. The Nymphalidae is a large, diverse family of about 4,500 species divided into nine subfamilies. The subfamily Nymphalinae which includes the fritillaries and anglewings, are the spiny brush-footed butterflies whose mature larvae are covered with stiff branching spines. Of these, the tribe of checkerspots and crescents occurs throughout the Northern Hemisphere. There are seven representatives in Wisconsin: four checkerspots and three crescents. Only the two pearl crescents are common; the tawny crescent (*Phyciodes batesii*) and the gorgone checkerspot (*Chlosyne gorgone*) are of special concern in Wisconsin by virtue of rarity. The tawny crescent has disappeared from much of the Eastern range and is under review for listing by the U.S. Fish and Wildlife Service. It is considered to be moderately associated with barrens. Tawny crescents may be seen flying with the pearl crescent (*Phyciodes tharos*) and the northern pearl crescent (*Phyciodes pascoensis*) with which it can be confused (Maxwell and Ferge, 1994). See Scott (1986) for a description of the three species.

Range. The tawny crescent ranges from Maine, New York, and Pennsylvania to southern Quebec and Ontario to the northern Great Lakes states, Manitoba, Nebraska and Colorado. Scattered populations are reported from the Appalachian states (Opler and Krizek, 1984).

A few reports of the species exist from far northern Bayfield County, Marathon County, and the northeastern counties of Florence, Forest, and Marinette (NHI, 1994). Kuehn reported the species "as far south as Adams and Juneau Counties" (1983). Most recently the butterfly has been reported from Oneida, Oconto (Ferge, 1990; Ferge, 1991), Outagamie (Kons, 1989), and Monroe

Counties (Maxwell and Ferge, 1994). In Karner blue range, the tawny crescent has been reported from wetland areas of Namekagon Barrens and Crex Meadows in Burnett County (Ferge, 1990; NHI, 1994).

Habitat. Habitat of the tawny crescent is primarily moist situations in the Midwest (Opler and Krizek, 1984; Ferge, 1990b; Swengel, 1991), though the species inhabits dry, rocky bluffs above rivers or rocky upland pastures with much big bluestem grass in the Appalachians (Opler and Krizek, 1984) and the Northeast (Scott, 1986). At Fort McCoy the species was found in wet areas: sedge meadow, wet trail near a creek, wet-mesic forest, moist opening in oak savanna (Maxwell and Ferge, 1994). In Oconto County the species occurs with the northern blue butterfly in jack pine barrens.

Life History. Unlike the multi-voltine pearl crescent (*Phyciodes tharos*) with which it may be confused, the tawny crescent has only one generation per year. The adults fly from mid-June to mid-July in Wisconsin. The species has been collected July 17 in Outagamie County (Kons, 1989). The larval food plant used by the tawny crescent in Wisconsin is unknown. *Aster undulatus* is the only species of aster mentioned by researchers to support the larvae in the wild. *A.undulatus*, a species of dry habitat, does not occur in Wisconsin (Shinners, 1941; Gleason and Cronquist, 1991; U.W.Herbarium, pers.comm.). Eggs are laid in batches on the underside of aster leaves, hatch in about a week, and the larvae live communally in webs on the underside of the plants, feeding on the leaves of the host plants. The third instar larva enters diapause and completes development in early spring (Opler and Krizek, 1984). Opler states that the larvae overwinter at the base of the host plant (1985).

Management Concerns. Until the larval food plant of the tawny crescent is known, all asters in *P.batesii* sites must be considered necessary to the survival of the butterflies. Specifically, the following species occur in barrens habitats: *Aster umbellatus, A. junciformis, A. simplex, A. puniceus.* The tawny crescent is a univoltine species and may therefore be vulnerable to fire during any period of the year. However, because the species is found in Wisconsin on asters in moist areas, the butterflies may be protected from fire on the landscape. Within the barrens mosaic, populations of the butterfly are vulnerable to isolation.

Mottled Dusky Wing (*Erynnis martialis* Scudder)

Taxonomy and Status. Only two of the four subfamilies of skippers (Hesperiidae) in North America occur in the Midwest, the branded skippers (Hesperiinae) that perch primarily with fore and hind wings at an angle and the open-winged skippers (Pyraginae) that land with wings open. *Erynnis* belongs to the latter group and is the genus of black dusky wing skippers. Ferge (1990) lists eight *Erynnis* species in Wisconsin. Refer to Scott (1986) for a description of the species. The mottled dusky wing has no federal status but is of special concern in Wisconsin because it is especially vulnerable to extirpation from the state. The species is highly associated with barrens.

Range. The mottled dusky wing ranges from Massachusetts and New York westward through the Great Lakes area to western Iowa and southward to Georgia and central Texas. Isolated populations occur in the Black Hills and central Colorado. In Wisconsin, the skipper is considered locally uncommon in the southwest (Swengel, 1991) and "common at times" northward along the western counties (Kuehn, 1983). Early collectors found this skipper common in the area of Racine and Milwaukee and reported the species from Dane and Sauk Counties as well (Ebner, 1970). Kuehn reports the skipper from Burnett, Eau Claire, Douglas, Juneau, and Waukesha Counties (1983). The species was reported in Brown County in the early 1980's but in recent years the mottled dusky wing has been reported only from sand prairies and barrens in Burnett and Jackson Counties (NHI, 1994).

Habitat. The mottled dusky wing is most often found in hilly habitat such as those sites where it occurs in the Loess Hills of Iowa. In the eastern United States it is found in shale or serpentine barrens with acidic soils, often near woods or shrubby areas (Opler and Krizek, 1984). The butterfly is an associate of Karner Blue butterflies in the grassy openings of pine barrens in New York, Massachusetts, and New Hampshire where the vegetation is much the same as in Midwestern openings (Schweitzer, 1994). Mottled dusky wings inhabit both prairies and barrens in Wisconsin and Swengel has found the species in Wisconsin sites with up to 55% woody cover (1994).

Life History. There are two generations per year of mottled dusky wings with adults flying in the last week of May to the first week of June and mid-July to early August in Wisconsin (Swengel, 1994). In the western states, males perch on hilltops awaiting females though this behavior is less common in Wisconsin. Nectaring has been observed on hoary vervain (*Verbena stricta*), gromwell (*Lithospermum* spp.), and bush houstonia (*Houstonia* spp.) (Opler and Krizek, 1984). Eggs are laid singly on the flower pedicels of the host plant. Like most *Erynnis* spp., the larvae live in leaf nests and feed on the leaves of woody plants. In this case, the caterpillars feed strictly on New Jersey Tea (*Ceanothus* sp.) (Opler and Krizek, 1984). *Ceanothus americanus*, considered the most often used larval food plant in the East, inhabits mesic habitat such as oak openings and mesic prairie in Wisconsin as well as the xeric sites. *Ceanothus ovatus* (*C.herbaceous*) inhabits the pine barrens and is the likely host of *Erynnis martialis* in Karner blue butterfly range (Curtis, 1959). Full grown larvae hibernate in a leaf shelter and pupate in a cocoon the following spring (Opler and Krizek, 1984).

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In this case, research into locations of larvae and cocoons would be most valuable to generate further informed land management decisions in regard to mottled dusky wings.

Schweitzer (1994) has commented that the frequent fires at Crex Meadows in Burnett County may be working reasonably well for this species, but numbers would probably increase with less fire. As mentioned above, larvae and pupae are above the ground. Thus, the species is particularly vulnerable to spring burns until the adults emerge in late May. In the fall, larvae are present in the vegetation as well. At Namekagon Barrens in Burnett County, Ferge (1989) found the species in firebreaks where nectar sources were most abundant rather than in the burn units. The host plant, also known as redroot because of the large gnarly root, is able to withstand fire. Curtis names both *Ceanothus ovatus* and wild lupine as heavy-seeded species that appeared after a fire at Crex Meadows in 1956 (Curtis, 1959). In New York, the mottled dusky wing was very scarce at a large site maintained by August mowing which would presumably eliminate the second brood larvae. Schweitzer suggests mowing sections of habitat during the dormant season if *Ceanothus* is present (1994).

Persius Dusky Wing (*Erynnis persius* Scudder)

Taxonomy and Status. Only two of the four subfamilies of skippers (Hesperiidae) in North America occur in the Midwest, the branded skippers (Hesperiinae) that perch primarily with fore and hind wings at an angle and the open-winged skippers (Pyraginae) that land with wings open. *Erynnis* belongs to the latter group and is the genus of black dusky wing skippers. Ferge (1990) lists eight *Erynnis* species in Wisconsin. The Persius dusky wing is very often confused with the wild indigo dusky wing (*E.baptisiae*) and the columbine dusky wing (*E.lucilius*). These three species are often referred to as the "Erynnis persius complex". Refer to Opler and Krizek (1984) for a description of the species, however these species cannot be reliably separated in the field and usually requires a specimen under magnification (Schweitzer, 1994). A suspected *E.persius* after early June is definitely NOT a Persius dusky wing. A good photo can rule out the species but not confirm it. To complicate matters further, *E.baptisiae* does not confine itself to *Baptisia* species but uses lupine for the larval food plants as well (Schweitzer, 1994).

Other subspecies of *E.persius* occur in the western United States. *Erynnis persius persius*, the subspecies in Wisconsin, has no federal status although some believe it should be a candidate for listing (Schweitzer, 1994). It is of special concern in Wisconsin because it is very vulnerable to extirpation from the state. The species is highly associated with the barrens community.

Range. The historical range of the Persius dusky wing extends through New York, Massachusetts, Pennsylvania, Michigan, Wisconsin, and Minnesota. Records exist from a few other eastern states as well as Quebec and Ontario (Schweitzer, 1986). The species occurs in the central sands region and northwestern barrens areas of Wisconsin (Ferge, 1990). In the last six years the species has been reported from Adams (Ferge, 1989), Juneau, Jackson, Monroe, Clark, and Burnett Counties. A site in Menomonie County was discovered in 1992 (NHI, 1994).

Habitat. In the eastern United States, the Persius dusky wing is said to inhabit wet areas with willows or aspens, open fields, or open areas in forest (Opler and Krizek, 1984). The species is a lupine-feeder and an associate of Karner blue butterflies in the grassy openings of pine barrens in New York, Massachusetts, and New Hampshire where the vegetation is much the same as in midwestern openings (Schweitzer, 1994). In Wisconsin, the skipper inhabits jack pine-oak barrens (Swengel, 1994). Swengel has found species of the Persius dusky wing complex in sites with up to 50% woody cover in Wisconsin (1994). At Fort McCoy in Monroe County, Wisconsin the species is found on sites supporting Karner blue butterflies in both open and shady oak woodland with the groundlayer rich in grass and herbs. The Persius dusky wing has been found at Fort McCoy with the dusted skipper (*Atrytonopsis hianna*), the pine elfin (*Incisalia niphon*), the roadside skipper (*Amblyscirtes vialis*), and several other dusky wings (*Erynnis icelus, juvenalis, brizo*) (Maxwell and Ferge, 1994).

Life History. The Persius dusky wing flies from mid-May to mid-June in Wisconsin (Ferge, 1990), about one to two weeks earlier than the first Karner blue butterfly flight. Males perch all day on ridges or hilltops awaiting females. Eggs are laid singly on the underside of host leaves. Larvae eat the leaves and live in rolled-leaf nests. Two known larval food plants are *lupinus perennis* and yellow wild indigo (*baptisia tinctoria)* though willows and poplars are reported as the primary hosts in the eastern states (Opler and Krizek, 1984). Yellow wild indigo is primarily a species that occurs east of Wisconsin and has been found in the state only occasionally. Full grown Persius dusky wing larvae hibernate in leaf shelters and pupate in the spring (Opler and Krizek, 1984).

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In this case, research into dispersal ability, response to mowing and timber harvest, and the intersection between sets of Persius dusky wing-inhabited patches of lupine and Karner blue-inhabited patches of lupine would be most valuable to generate further informed land management decisions in regard to Persius dusky wings.

Schweitzer attributes regional declines in the species primarily to fire suppression (1985) which contributes to habitat loss. Schweitzer has stated that management for this species would be essentially the same as for Karner blue butterflies (1990) and recommends no less than five years between fires (1994). The skipper has been found at Fort McCoy in recently burned areas (Maxwell and Ferge, 1994), although this should not be interpreted to mean that these areas support viable populations. The Persius dusky wing spends no part of the year underground, is univoltine, and has poor dispersal ability (Swengel, 1993). These characteristics make the species particularly vulnerable to fire, certainly more so than Karner blues. There is no question that it is more rare than Karner blues in Wisconsin and the few small populations in specialized habitats

make the species especially slow to recover from fire (Swengel, 1995). Plans for corridors and attention to both larval food and nectar plants in burn units can help provide for recolonization following local extirpations. Like the Karner blue, this species is believed to have always existed in metapopulations characterized by local extinctions and colonizations within a dynamic landscape (Givnish, et al., 1988).

Soil disturbance can be beneficial to the species. In Ohio, a bulldozed firebreak in oak barrens produced lupine populations that were colonized the following years by Persius dusky wings (Chapman, etal., 1993). Mowing considerations for roadside maintenance indicate that fall mowing may help to maintain the habitat but food plants should not be cut prior to mid-July (Schweitzer, 1986).

Leonard's Skipper (*Hesperia leonardus* Harris)

Taxonomy and Status. Only two of the four subfamilies of skippers (Hesperiidae) in North America occur in the Midwest, the branded skippers that perch primarily with fore and hind wings at an angle and the open-winged skippers that land with wings open. The Leonard's skipper, *Hesperia leonardus*, is a member of the group of branded skippers (Hesperiinae), a group so named for the special scent scales on the forewing of the male. Refer to Opler and Krizek for a description of the species (1984) or the Bureau of Endangered Resources for materials and photos to distinguish the species from others of its kind. The Leonard's skipper has no federal status but is of special concern in Wisconsin and is highly associated with the barrens habitat.

Range. The Leonard's skipper is one of many *Hesperia* species in the eastern United States. However, it is the only butterfly in most of that area that flies only in the fall (Opler and Krizek, 1984). *Hesperia leonardus ssp.leonardus* occurs from New England westward to Ontario and Minnesota and southward into North Carolina, Louisiana, and Missouri. The Pawnee skipper, *H.l.ssp.pawnee*, covers the Plains area and intergrades with *H.l.ssp.leonardus* in Minnesota and Wisconsin and the Loess Hills of western Iowa (Scott and Sanford, 1981; Spomer, et al., 1993). See Scott and Sanford (1981) for a discussion of the distinquishing characteristics of the subspecies. A third subspecies is found only along the Platte River in Colorado (Scott, 1986).

Of the three bluestem-feeding skippers in Wisconsin barrens, (*Hesperia leonardus, H.metea, Atrytonopsis hianna*) the Leonard's skipper is the most widespread and abundant skipper. It has been reported from Sauk and Juneau Counties, Green County, Grant, Jackson, Burnett, and Bayfield Counties in the western part of the state as well as Menomonee County (Ferge, 1988; 1989; 1990) and Marinette County (Ebner, 1970). Ebner reported possible collections in the Milwaukee area over 70 years ago (1970).

Habitat. Leonard's skipper inhabits open grassy areas or meadows, grassy slopes, pine-oak barrens (Opler and Krizek, 1984), and prairies (Hess and Sedman, 1994), especially ridgetop prairies (Spomer, et al., 1993). In Wisconsin it may be found in both prairies and barrens and in woodland clearings with up to 55% woody cover (Swengel, 1994). *H.l.leonardus* appears to inhabit moist meadows more often than *H.l.pawnee* which is more closely associated with dry prairie (Scott and Stanford, 1981). The species appears to be associated with small stands of bluestem grass that harbor the dusted skipper (*Atrytonopsis hianna*) (Opler and Krizek,1984) and the cobweb skipper (*Hesperia metea*) (Swengel, 1994). It is often found in at roadside puddles and concentrations of *Liatris aspera* (Maxwell and Ferge, 1994).

Life History. There is one generation per year of Leonard's skippers. The adults fly from mid-August to mid-September or even into October in Wisconsin (Swengel, 1994) Males perch all day near *Liatris* species awaiting females (Opler and Krizek, 1984). The butterflies choose purple flowers most often for nectar (Opler and Krizek, 1984) and depend most strongly on *Liatris* species (Spomer, et al., 1993; Hess and Sedman, 1994). In Wisconsin they use rough blazingstar (*L.aspera*) and dwarf blazingstar (*L.cylindracea*) but have also been observed at silky and smooth asters (*Aster* spp.) (Swengel, 1994). Elsewhere they have been observed on goldenrod (*Solidago* spp.), Joe Pye Weed (*Eupatorium purpureum*), thistles (*Cirsium* spp.), bergamot (*Monarda fistulosa*),and annual sunflower (*Helianthus annuus*) (Scott and Stanford, 1981; Spomer, et al., 1993; Hess and Sedman, 1994; Maxwell and Ferge, 1994).

Shortly after emerging from the egg, the young larvae hibernate and mature during the following summer (Scott and Stanford, 1981). Like all *Hesperia* spp. they probably live in silken sacs at the base of the grasses and leave the shelter only to feed (Opler and Krizek, 1984).

Native grasses are the larval food plants, both *Andropogon gerardii*, and *A.scoparius* with needlegrass (*Stipa* spp.) and dropseed (*Sporobolis heterolepsis*) (Swengel, 1993) as well as *Panicum virgatum, Eragrostis alba*, and *Agrostis* spp. (Opler and Krizek, 1984). The larvae pupate in early August probably amid plant debris like other *Hesperia* species (Opler and Krizek, 1984; Schweitzer, 1985).

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind.

From early spring to August, the Leonard' s skipper is a caterpillar living primarily in the base of the grasses. Like most skippers it is quite vulnerable to fire, though cool, fast-moving fires are likely less lethal (Schweitzer, 1985). Although Leonard's skippers are present at Crex Meadows in Burnett County, Schweitzer believes their numbers would probably increase with less fire management (1994). Among rare grass-feeding skippers, Leonard's skippers appear to be more tolerant of habitat degradation as well as better colonizers than cobweb or ottoe skippers (Swengel, 1994). In Illinois, the species has been observed to decrease in numbers at Lake Argyle State Park. Researchers believe this to be in response to the planting of pines and resulting loss of native habitat (Hess and Sedman, 1994).

Cobweb Skipper (*Hesperia metea* Scudder)

Taxonomy and Status. Only two of the four subfamilies of skippers (Hesperiidae) in North America occur in the Midwest, the branded skippers that perch primarily with fore and hind wings at an angle and the open-winged skippers that land with wings open. The cobweb skipper, *Hesperia metea*, is a member of the group of branded skippers (Hesperiinae), a group so named for the special scent scales on the forewings of the male. The species of branded skippers are numerous in the eastern United States. Refer to Opler and Krizek for a description of the species (1984). The cobweb skipper has no federal status but is proposed Threatened in Wisconsin and is highly associated with barrens.

Range. The cobweb skipper is known from the Gulf coast through the Appalachians to New York and up the Mississippi Valley into the Great Lakes states. *Hesperia metea ssp.licinus* is restricted to Texas and Arkansas (Scott, 1986) with gradation between the subspecies in the Ozarks.

Ebner reported the species to have been common in the Racine area of Wisconsin in the distant past and specimens are known from Marinette and Oconto counties (1970) but within the last five years, the species has been reported from only a few isolated sites of barrens habitat in Burnett, Eau Claire, Monroe, Jackson, and Sauk Counties (NHI, 1994; Swengel, 1994).

Habitat. Habitat of the cobweb skipper has been described as grassy fields or grassy forest clearings (Ebner, 1970; Scott, 1986). Across the midwestern and eastern states however, the species in some cases inhabits primarily shale, serpentine, sand, or pine-oak barrens on dry or rocky sites (Opler and Krizek, 1984). It occurs where bluestem grasses (*Andropogon* spp.), the larval food plants, are dominants of the groundlayer. In the Ozarks and Pennsylvania the skipper inhabits dry, often rocky hillsides closely associated with woodland areas (Shapiro, 1965; Heitzman and Heitzman, 1969) and usually near the top of the slope where the bluestem grasses are most prominent. Some cobweb sites in Wisconsin may have up to 45% woody cover (Swengel, 1994).

The cobweb skipper is found in both dry prairies and barrens in Wisconsin. In the barrens community, locations of the cobweb skipper correlate strongly with the dusted skipper (*Atrytonopsis hianna*) and probably also Leonard's skipper (*Hesperia leonardus*), both species of concern in Wisconsin (Swengel, 1994). In other states as well, the dusted and cobweb skippers are found together (Shapiro, 1965; Heitzman and Heitzman, 1974). At Fort McCoy in Monroe County, the sites of the cobweb skipper coincide with those of the ottoe skipper (*Hesperia ottoe*), another grass-feeding skipper (Bleser, pers.comm.).

Life History. *Hesperia metea* is usually the first branded skipper to fly in the spring. It may be found in mid-to-late May with the dusted skipper which emerges slightly later (Heitzman and Heitzman, 1974; Opler and Krizek, 1984). The cobweb skippers fly for only a few weeks and the less-flighty females can be found in the litter at the base of the host plants where they lay their eggs. Females are known to emerge about six days after the males and the following ten days defines the survey period (Shapiro, 1965) when they are best observed during cooler periods of the day. Although there are skippers similar in appearance to the cobweb skipper, the early flight period is distinctive for this species.

Wild strawberry (*Fragaria* spp.) and bird's-foot violet (*Viola pedata*) are favorite nectar sources (Opler and Krizek, 1984; Heitzman and Heitzman, 1969) which the butterflies visit primarily in the morning hours (Shapiro, 1965). Labrador tea (*Ledum groenlandicum*), winter cress (*Barbarea* spp.), and red clover (*Trifolium pratense*) are also used by the butterflies (Opler and Krizek, 1984) as are wild hyacinth (*Camassia scilloides*), wild larkspur (*Delphinium*

carolinianum), and vervain (*Verbena* spp.) by females later in the season (Heitzman and Heitzman, 1969). *D. carolinianum* does not occur in Wisconsin though *D. virescens* occurs in prairies and barrens in Jackson County and north to St. Croix and Dunn Counties. *Camassia scilloides* is an endangered species associated with damp prairies, roadsides, and rights-of-way in a few southern Wisconsin counties that are outside Karner blue range (BER, 1993). Recently, skippers in Wisconsin have been observed at lyre-leaved rock cress (*Arabis lyrata*) and wood betony (*Pedicularis canadense*) (Swengel, 1994).

The species is single-brooded and, like all *Hesperia*, the larva lives in a silken sac at the base of grasses. The cobweb larva leaves its shelter only to feed on bluestem grasses, particularly *Andropogon scoparius*, but also *A.gerardii* or *A.virginicus* (Shapiro, 1965; Scott, 1986). The later instars actually tunnel below ground where they aestivate for long periods in late summer and early fall. The larvae overwinter in tightly sealed chambers between leaf blades in the center of the grass plant. Mortality appears to be quite high during hibernation (Heitzman and Heitzman, 1969). Pupation occurs early in the spring amid debris (Opler and Krizek, 1984).

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In this case, research into larval location, and timber management would be most valuable to generate further informed land management decisions regarding the cobweb skipper.

The cobweb skipper is narrow in its habitat requirements and tolerance to habitat degradation (Swengel, 1994). Within the barrens habitat in Wisconsin, locations with abundant Karner blue butterflies were not found by Swengel (1994) to favor cobweb skippers or vice versus. The open grassy habitat of cobweb skippers within the barrens may not offer the right conditions for wild lupine.

In Burnett County, Ferge has found the species at Namekagon Barrens in openings of jack pine-oak scrub and, in areas managed with fire, along the fire breaks at the edges where nectar sources were most abundant (1989). Because the animals pupate in the debris in early spring, April or May burns could be expected to result in losses to the populations of skippers. Schweitzer has found survival of cobweb skippers to be good after cool, fast-moving fires (1985). Shapiro found the skippers in burned-over sites the second year following wildfire which has allowed the bluestem grasses to become dominant (1965). Woody growth, of course, will shade out the grasses creating a less desirable habitat for the skippers. Fall mowing and fall or winter timber management activities may be relatively innocuous when the larvae are underground, though information on the depth in the soil to which the larvae tunnel is not yet known.

Dusted Skipper (*Atrytonopsis hianna* Scudder)

Taxonomy and Status. Only two of the four subfamilies of skippers (Hesperiidae) in North America occur in the Midwest, the branded skippers that perch primarily with fore and hind wings at an angle and the open-winged skippers that land with wings open. The dusted skipper, *Atrytonopsis hianna*, is a member of the group of branded skippers (Hesperiinae), a group so named for the special scent scales on the forewing of the male. There are eight species in the genus *Atrytonopsis* that inhabit North America. The dusted skipper is the only species in the eastern United States. See Opler and Krizek (1984) for a description of the species or the Bureau of Endangered Resources for materials and photos to distinguish the species from others of its kind. *Atrytonopsis hianna* has no federal status but is a species of special concern in Wisconsin and highly associated with barrens habitat.

Range and Habitat. *Atrytonopsis hianna* ranges from southern New England to the Plains states and southern Manitoba. Another subspecies, *A.h.loammi*, inhabits Florida, North Carolina, and Louisiana. Little was known about the dusted skipper when Ebner wrote *Butterflies of Wisconsin* (1970) except its possible occurrence in the Racine area. Dusted skippers have since been found to be locally uncommon in sand barrens and dry prairie in western Wisconsin (Swengel, 1991). It has been reported from Burnett, Eau Claire, Monroe, Jackson, Grant, and Sauk Counties (Ferge, 1988; Ferge, 1989).

Habitat. Across its range the species is found with bluestem grasses in dry habitats including old fields, woodland clearings, cedar glades, and rights-of-way (Heitzman and Heitzman, 1974; Opler and Krizek, 1984). In Wisconsin the species has been found more often in pine barrens than in dry prairies where locations of the dusted skipper correlate strongly with the cobweb skipper (*Hesperia metea*) and probably Leonard's skipper (*Hesperia leonardus*), both species of concern in Wisconsin (Swengel, 1994). The dusted and cobweb skippers are consistently found together in other states as well (Shapiro, 1965; Heitzman and Heitzman, 1974) The dusted skipper has also been found nectaring on the same blossoms as the phlox moth (*Schinia indiana*) in Wisconsin (Balogh, 1987).

Life History. The dusted skipper has one flight period except in the far southeastern portion of the range. Adults fly mid-to-late May into early June in Wisconsin (Swengel, 1994), the dusted normally emerging one to two weeks later than cobweb skippers (Heitzman and Heitzman, 1974). Males perch on the ground or grass stems throughout the day to await

females (Scott, 1986) and are quite aggressive in their territorial displays. Females emerge about six days after the males and the following ten days is the optimum survey period (Shapiro, 1965).

Larvae feed on the leaves of native grasses, primarily *Andropogon gerardii* and *A. scoparius*. They live in rolled or tied leaf tents on the grasses, though higher in the plant than do the *Hesperia* larvae (Scott, 1986). Although both cobweb and dusted skippers use the same food

plants during the same time period, resource partitioning appears to minimize competition. *Hesperia metea* instars live at the base of grass clumps while *Atrytonopsis hianna* instars live one to several feet above the ground in the grass plants (Heitzman and Heitzman, 1974).

The dusted skipper is often discovered while visiting flowers in late afternoon and early morning (Shapiro, 1965) though a better assessment of numbers may be made when the skippers are most active during the hotter part of the day. It has been observed nectaring at phlox (*Phlox* spp.), and puccoon (*Lithospermum* spp.) in Wisconsin with fewer observed visits to bird's foot violet (*Viola pedata*) and wild lupine (*Lupinus perennis*)(Swengel, 1994). Other nectar sources are Japanese honeysuckle (*Lonicera japonica*), blackberry (*Rubus* spp.), red clover (*Trifolium pratense*), wild strawberry (*Fragaria* spp.), vervain (*Verbena* spp.), and wild hyacinth (*Camassia scilloides*) (Shapiro, 1965; Opler and Krizek, 1986). The latter three species are most often used by dusted skippers in the Ozarks (Heitzman and Heitzman, 1974). In Wisconsin, *Camassia scilloides* is an endangered species associated with damp prairies, roadsides, and rights-of-way in a few southern counties that are outside Karner blue range (BER, 1993).

Dusted skippers hibernate as mature larvae (Scott, 1986) and overwinter in a sealed nest at the base of the host plant (Opler and Krizek, 1984). Pupation occurs in the spring at the base of the grass clump 1-3 inches above the ground in a case of silk and grass leaves (Heitzman and Heitzman, 1974).

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In this case, research into locations of dusted skippers within Karner blue-inhabited areas would be most valuable to generate further informed land management decisions because the skippers appear to require management differently than would be used for Karners.

Compared to other rare grass-feeding skippers in the barrens community, dusted skippers appear to be more tolerant of habitat degradation and be better colonizers than either the cobweb or ottoe skippers. Within the barrens habitat, locations with abundant Karner blue butterflies were not found by the Swengels' study in Wisconsin to favor abundance of dusted skippers or vice versus (Swengel, 1994). The open grassy habitat of dusted skippers within the barrens may not be the right conditions for wild lupine. Pupation up to three inches above the ground and larvae up to several feet above the ground places this species in a location vulnerable to mortality by any destruction of inhabited grasses throughout the year.

Tiger Beetles (*Cicindela patruela patruela* (Dejean)) and (*Cicindela patruela*

huberi (Johnson))

Taxonomy and Status. The subfamily of tiger beetles, Cicindelinae, is in the insect order Coleoptera. Taxonomists have also variously classified them as a subfamily, tribe, or supertribe of the family Carabidae, the carabid beetles. Cicindelids are world-wide with the exception of Tasmania, Antarctica, and remote oceanic islands (Pearson, 1988). There are 2,028 species of tiger beetles in the world with 111 species in the United State (Pearson and Cassola, 1992). Color variation is typical of the family Cicindelidae and is exhibited by a number of the tiger beetles species. Color is also influenced by environment and may even vary by the age of the individual (Graves, 1963; Pearson, 1988).

There are three known races of the tiger beetle, *Cicindela patruela*, which are distinguishable by the predominant color of the individuals in a population. *C.patruela patruela*, the nominate race, is called the green race; *C.p.consentanea*, the black race; and individuals of *C.p.huberi* are predominantly muddy green to bronze brown.(Lawton, 1970; Johnson, 1989). *Cicindela patruela* may be found in Willis' key to the species (1968) and *C.p.huberi* is described by Johnson (1989). Both Wisconsin subspecies are globally rare and vulnerable to extinction though neither have federal status. Both are of special concern in Wisconsin and highly associated with barrens. *C.p.patruela* is rare and uncommon in the state and *C.p.huberi* is of uncertain status because so little occurrence information is available.

Range. The green race occurs in eastern Ontario and ranges across the northeastern United States as far west as Minnesota and south into the southern Appalachians of the Carolinas and Tennessee. Collections from Wisconsin come from Dane, Shawano, Sauk, Columbia, Jackson, and Douglas Counties (NHI, 1994). The black race has been found only in the New Jersey Pine Barrens and Long Island, New York. *C.p.huberi* has been collected in a few sites in central Wisconsin in Monroe, Juneau, Columbia, Adams, and Iowa Counties (Johnson, 1989; NHI, 1994). Much of this area is within the Great Wisconsin Swamp area of the former Glacial Lake Wisconsin. The population of *C.patruela* here was most likely isolated during the glacial period and evolved separately, developing its own coloration (Johnson,1989).

Habitat. Like the majority of North American temperate zone species of Cicindelidae, *C.patruela* inhabits relatively exposed, dry situations with little vegetation including paths, roads, bare fields, and sandy levels (Balduf, 1935). In Michigan it is frequently found in association with the more common species, *C.longilabris*, of the conifer and mixed forests of the Upper Peninsula. *C.longilabris* inhabits the dry, sandy country of jack pine, blueberries, and reindeer moss (*Cladonia* sp.) (Graves, 1963). In Minnesota, Ron Huber describes the habitat of *C. patruela* as sunlit, sandy jackpine openings, often created by roads, clearings, firebreaks (1988).In Ontario, a whole colony lives on a sandy lane (Wallis, 1961). *C.p.huberi* was collected in Wisconsin on sandy lanes in jack pine-oak forest with much blueberry undergrowth, "usually on dry upland, away from the bogs...", and appears to prefer the grass along the lanes (Johnson, 1989). Lawton did not find *C.p.huberi* in areas devoid of grasses (1970).

Life History. Life history of the tiger beetles was first described by Shelford in the Chicago area in 1909. He did not discuss *C.patruela* for which there is still little detailed information. However, the following information from Criddle (1907), Shelford (1909), Balduf (1935), Wallis (1961) and Pearson (1988) is enlightening concerning the genus.

The female beetle lays about 50 eggs, each about 2mm long. Each egg is laid singly in holes she makes 3-5mm deep in bare, open ground. With species observed in Canada this process takes 15-25 minutes (Balduf, 1935). The larva hatches in 9-29 days (Pearson, 1988), digs its way out, then turns around and begins to deepen the burrow, to 10-15cm by beetles in the Chicago area (Shelford,1909). The larva then excavates somewhat around the entrance and packs it well to the size of its head. The head of the larva and the special chitinized plate behind the head which usually bears sand and soil, plug the top of the burrow and effectively blend with the surroundings. The larva waits with jaws agape and feet and spurred back wedged against the sides of the burrow for passing prey. Then it throws itself out and snaps the mandibles shut, usually on smaller invertebrates.

Cicindela larvae go through three instars (Pearson, 1988). The tunnel is enlarged after each molt and the depth of the tunnel ranges from 15-200cm depending on the species and instar (Pearson, 1988). Typically, the first *Cicindela* instar feeds about 3-4 weeks before crawling to the bottom of the burrow to molt. After 5-7 days the second instar larva enlarges the opening and feeds about 5 weeks. The second instar molts after another week and it is the third instar which deepens the burrow the farthest and overwinters (Shelford, 1909). *C.patruela* requires two years to complete its life cycle. From June eggs, the second or third instar larva overwinters. During the second summer, pupation occurs and immature adults overwinter to appear in May, mate, and leave the next generation of eggs in June. Two groups of the species cycle through the life stages but offset one year from each other with adults of one group mating and laying eggs while the other group is in the larval form preparing for pupation (Smith, W. pers.comm.).

To prepare for pupation, the burrow is closed above. Some species even fill in part of the upper burrow before constructing the special pupal cell or an enlargement of the main burrow shaft.

Only a few minutes are required for the third instar larva to change to the pupal form, though the pupal stage may take up to 30 days (Pearson, 1988). Temperature probably affects pupal duration. In captivity, Shelford observed pupation to occur up to one week sooner under moist soil conditions (1909). After transformation the new adult must dig its way up through the column of soil which takes about three days (Pearson, 1988).

Hibernating burrows are usually quite deep. Adults and larvae of the same species usually overwinter in burrows of the same depth (Wallis, 1961). Burrow depths recorded in Manitoba may reach 1.8m, though some may be as short as 15cm (Criddle, 1907). The longer ones angle down about 7-20cm, then drop further vertically, perhaps taking several days to create. The beetle will throw out the dirt for the first 15-30cm, then this upper part is filled in loosely and the last 10-25cm or more are left unfilled. Depth and angle of the burrows varies depending on species. Within species, the depth also varies with substrate, water table, and other edaphic factors. Shelford found that larvae dig deeper burrows if the soil surface temperature is warmer (1909). The burrows may be dug 2-3 times deeper in sandy soil than in clay (Criddle, 1907). Most but not all beetles dig below the frostline to hibernate (Criddle, 1907; Wallis, 1961). Criddle observed that the beetles prefer a south-facing slant and are attracted to shallow holes in which to dig their overwintering burrows. The burrows of adults are often found grouped 2.5-5cm apart within a 60cm-diameter area (Criddle, 1907).

Adults are swift diurnal predators with excellent short-distance acuity. They may be considered the invertebrate equivalent to the cougar or wolf in the insect food chain. Ants are the favorite prey item (Huber, 1988). Some *Cicindela* are more selective of their prey than others which will feed on any kind of land Crustacea. Although the adults avoid predators well, they may become food for larger beetles, robber-flies, dragonflies or black widow spiders as well as small vertebrates such as the kestrel or kingbird (Huber, 1988). Balduf reports predation by skunks in Kansas (1935) and Criddle reports badger predation in Manitoba (1907). Parasitoids are their major enemies, particularly parasitic wasps and bombyliid flies (Pearson, 1988).

Adults may take cover under sticks or stones during the day but usually they dig shallow, quickly-created burrows for shelter from cold, rain, and darkness and also perhaps against extreme heat and drought. These burrows are usually no more than about 3cm deep. The adult beetles respond quickly to weather changes, becoming quite inactive under clouds, but again prompted to activity by sunshine. On rainy or gray days as well as on very hot, dry days, the beetles may remain constantly underground. Some species burrow in for the night by late afternoon and remain until mid-morning (Balduf, 1935). Larvae too have been observed to pass long intervals of inactivity in their burrows during the summer. At these times they plug the openings closed. This behavior is probably a response to extreme heat or dryness (Balduf, 1935).

Management Concerns. Tiger beetles as a group are habitat specialists. This is one reason why Cicindela has been suggested as an appropriate indicator taxon for regional patterns of biodiversity (Pearson and Cassola, 1992). However, this specialization and their position as

predators makes tiger beetles highly susceptible to habitat changes. On the other hand, they are less area sensitive and able to maintain viable populations in small areas of habitat (Pearson and Cassola, 1992). Temperature and water loss are the most important physical factors for adults. Tiger beetles maintain high body temperatures just below their lethal limits and are primarily ectothermic, requiring behavioral adaptations to maintain temperatures for functioning. The reflectivity of tiger beetle elytra (wings) varies greatly between species and functions in thermoregulation; diurnal beetles being more reflective than those that are active at night, for instance. Color variation probably aids in thermoregulation as well (Pearson, 1988).

The larvae are more sensitive to variation in edaphic factors than are the adults, particularly to soil moisture, soil composition, and temperature. The effect of changes in soil chemistry is yet unknown (Pearson, 1988). Because the beetles require a specific habitat, *C.patruela* is particularly vulnerable to habitat loss. Throughout its range the species has suffered loss of habitat to development.

Soil disturbance may be detrimental to the larvae depending on the instar and depth of the tunnel. The larvae drop quickly to the bottom of the burrow when threatened. Early season instars remain closer to the soil surface than the later stages. As mentioned above, the hibernating burrows are quite deep, especially in a sandy substrate. Although the hibernating depth of *C.patruela* is unknown, it is likely below the level of vulnerability to winter timber management activities. Because the beetles can dive below ground, fire poses little threat except in June when the eggs are vulnerable (Smith, pers.comm.). Research into the depth of hibernation of the larvae, the effects of soil chemistry changes on the larvae, and the effects of soil disturbance accompanying timber activities on both larvae and adults would be most valuable to generate further informed land management decisions in regard to the rare tiger beetles.

Wood Turtle (*Clemmys insculpta*)

Taxonomy and Status. The wood turtle belongs to the family, Emydidae, the pond and river turtles. Emydidae is the largest turtle family with 85 species worldwide in temperate and tropical climates excluding Australia. Refer to Oldfield and Moriarity (1994) for a description of the species. The wood turtle currently has no federal status but the U.S. Fish and Wildlife Service was petitioned to list the species as Federally Threatened in 1994. It is listed as Threatened in Wisconsin and Minnesota. In Iowa where only one population is known, the species is ranked as Endangered (Christiansen and Bailey, 1988). Most states that harbor the turtle have some legislation for protection. A Wisconsin Threatened species may not be collected without a permit from the Bureau of Endangered Resources of the Wisconsin DNR. In addition, salvaging a dead animal is in violation of the law unless the local conservation warden or the Bureau of Endangered Resources is contacted. Contact BER in Madison at (608) 266-7012.

Range. The turtle is found in Nova Scotia and northeastern United States then westward as far as

northeastern Iowa and eastern Minnesota. The range of the species reaches only as far south as northern Virginia. The turtles inhabit Wisconsin primarily north of a line from Green Bay to Prairie du Chien (NHI, 1994; Casper, 1995). South of this line, the wood turtle has been found in counties along the Wisconsin River with scattered reports in counties further east. The Wisconsin Herpetological Atlas Project has documented records of the wood turtle in all counties in Karner blue butterfly range with the exceptions of Barron, Dunn, Clark, and Juneau Counties , though the species is believed to occur in those counties as well (Hay, pers.comm.).

Habitat. In Wisconsin, the wood turtle is present in fast-moving rivers and streams such as the Black, Wisconsin, Brule, St.Croix, and Baraboo Rivers. Smaller tributaries with wood turtles include both warm and cold water streams. Wood turtles are almost exclusively riverine, inhabiting aquatic, riparian, and upland habitats primarily within a forested landscape. Wood turtles are considered semi-terrestrial and spend part of their lives in the uplands, though it appears that western individuals remain closer to the water than do those in the more eastern parts of the range. Vogt has found individuals in the river in July in Wisconsin (1981). In contrast, some individuals spend little time in the water (Nedrelo, 1994). Usually turtles forage in open, grassy meadows and deciduous woods adjacent to the rivers throughout the summer and return to the water in the fall. In Iowa, the turtles are more often seen moving through forest than in the water (Christiansen and Bailey, 1988). Brewster and Brewster (1991) found sandy stream beds, alder (*Alnus rugosa*) thickets interspersed with grass/sedge openings, upland foraging areas, and sandy, sunny nesting substrates to correlate with preferred wood turtle habitat in northern Wisconsin.

Life History. Wood turtles become active in late March to mid-April and bask on the sides of the river on warm spring days. They are diurnal and forage in midday. The turtles are omnivorous and consume most of their food on land (Ewert, 1985) eating forbs, willow leaves, berries, mushrooms, slugs, insects, and earthworms. They have also been observed consuming dead fish and birds. Vogt found spruce needles eaten by a turtle in Price County (1981).

Wood turtles mature when they are 14 years old or older (Oldfield and Moriarity, 1994) and they produce a single clutch per year. Mating occurs primarily in the spring though fall mating has been observed (Vogt, 1981). The females nest on sandbars, sandy riverbanks, abandoned railroad grades, and open sandy-soil hillsides. Females leave the water for nest sites in the late afternoon in June and nest communally. False nests may be dug before the female ultimately deposits her eggs. She produces a clutch of 4 to 12 (typically 7 to 9) eggs. The nesting process may take three hours or more. Unlike many other turtle species, there is some evidence that the sex of wood turtle embryos are not affected by the influence of incubation temperature (Bull, 1985).

Eggs develop in 58-71 days and the young emerge in mid-to-late August or September (Oldfield and Moriarity, 1994). Little is known about the behavior or habitat of young wood turtles. Very few young are ever found. Certainly the nests are highly predated in the present landscape but Vogt states that Agassiz in the 1890's found hundreds of adults and not one yearling (1981). The

Brewsters report the young to remain in close association with the edges of alders near rivers (1991). Wood turtles hibernate individually beginning in October under ice in bank undercuts and near log jams (Oldfield and Moriarity, 1994). They have also been found hibernating in muskrat burrows, under mud at the bottom of the river, or simply resting on the stream bed.

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In this case, research into the location and habitat uses of juveniles, upland habitat use by adults, and the effects of land management on predator populations would be most valuable to generate further informed land management decisions in regard to wood turtles.

Upland wood turtle habitat has been said to extend within 366 meters of the river (Ewert, 1985). Turtles in northern Minnesota stayed within 100 meters of the river (Oldfield and Moriarity, 1994). Similar data is not yet available from Wisconsin. Upland areas are important to the wood turtle for foraging and nesting. Any soil disturbance in upland areas used by the turtles should be done prior to June or after September.

Adult turtles are usually safe from predation but can be attacked by raccoons and dogs. Like other turtles, wood turtles are vulnerable to death by automobile while traversing the upland areas near rivers. Baby turtles are preyed upon by fish and large birds as well as the raccoons, skunks, and other small mammals that destroy nests. The combination of late maturation, single-clutches, and low survival of eggs and young creates a situation in which populations are dominated by, if not totally comprised of, adults. Wood turtles are slow, mild mannered animals and continue to suffer losses to collection for the pet trade. Protection of information on turtle sites will help to minimize these threats.

Loss of forested stream habitat to development is a threat to the wood turtle. Degradation of water quality and the resulting loss of the plants and small animals of the stream resulting from industrial activities and and agricultural runoff threatens the survival of the turtles. Monocultural management of timber lands removes the diversity of plants and animals that the wood turtle uses for food. Protection and maintenance of nesting sites against predation, collection, and natural succession as well as protection of habitats used by all life stages is needed to aid recovery for the wood turtle.

Blanding's Turtle (*Emydoidea blandingii* (Holbrook))

Taxonomy and Status. Emydidae is the family of pond, marsh, and box turtles. Emydidae is the largest turtle family with 85 species worldwide. The family reaches its greatest diversity in the

eastern United States and Southeast Asia. Emydidae are small to medium sized turtles with twelve marginal carapace scutes along each side and six pairs of scutes on the plastron. The elongated hind feet have some webbing. One species, *Emydoidea blandingii*, is recognized in the genus. There are no recognized subspecies. See Ernst and Barbour (1972) or Oldfield and Moriarity (1994) for a description of the species. Blanding's turtle is Threatened in Wisconsin and is under review for listing by the U.S. Fish and Wildlife Service. A Wisconsin Threatened species may not be collected without a permit from the Bureau of Endangered Resources of the Wisconsin DNR. In addition, salvaging a dead animal is in violation of the law unless the local conservation warden or the Bureau of Endangered Resources is contacted. Contact BER in Madison at (608) 266-7012.

Range. Blanding's turtles range from southern Ontario and Quebec south through the Great Lakes region, west to central Nebraska and the southeastern corner of South Dakota, south to Iowa, into the northeast corner of Missouri, the northern half of Illinois and Indiana and the northwestern corner of Ohio extending in that state along the southern border of Lake Erie. The distribution of this species is spotty and disjunct around margins of the range particularly in the East where relic populations may be found in scattered localities in eastern New York, Massachusetts, New Hampshire and Nova Scotia (Ernst and Barbour, 1972; Iverson, 1986).

The Blanding's turtle was formerly more widespread. Archeological records show the species to have inhabited central Missouri, southwestern Kansas and the Oklahoma panhandle during the Pleistocene as well as in Kansas during the late Pliocene (Kofron and Schreiber, 1985; McCoy, 1973). The turtle is found scattered throughout Wisconsin except for the northcentral region and a few counties east and south of Lake Winnebago in eastern Wisconsin (Vogt, 1981). While not documented by museum specimens, the species has also been observed in Bayfield and Barron Counties (Hay, pers.comm.).

Habitat. *Emydoidea* is found in marshes, ponds, swamps, bogs, lake shallows, backwater sloughs, shallow slow-moving rivers, protected coves and inlets of large lakes, oxbows, and pools adjacent to rivers; particularly in waters with a soft bottom and abundant aquatic vegetation. Blanding's turtles are found in rivers in Michigan (DeGraf and Rudis, 1983) but primarily prairie marsh and ponds in Minnesota (Oldfield and Moriarity, 1994). Prairie marsh or wet prairie is the preferred habitat in the western part of the range, especially associated with sandy soils (Kofron and Schreiber, 1985; Nyboer, 1992).

In Wisconsin, populations of Blanding's turtles studied by Ross and Anderson (1990) used ponds more often than the marshes which were available. Marsh habitat use was highest in early summer. Ross and Anderson think the use of these ponds as well as ditches might be for travel routes between feeding or activity centers (1990). Use of ponds with sand substrate and no aquatic vegetation was minimal in their study. Wetlands in which the cattails had been cleared in some areas were used by the turtles but not those with dense cattail mats indicating that availability of open water affects wetland use, at least by adults. Marsh habitat use was highest in

early summer. Higher water quality encourages invertebrate prey populations and those habitats in Wisconsin with higher dissolved oxygen (>5.0ppm) had greater use by the turtles. Eutrophic conditions are attractive to Blanding's turtles (Graham and Doyle, 1977; Kofron and Schreiber, 1985; Ross and Anderson, 1990) particularly in mid to late summer due perhaps to increased competition during times of high feeding rates (Rowe and Moll, 1991).

In Minnesota, the preferred habitat is calm, shallow water with rich aquatic vegetation. The turtles are found in marsh areas in large river floodplains in the state adjacent to sandy upland areas for nesting (Coffin and Pfannmuller, 1988). In Michigan the turtles use shallow weedy bodies of water such as permanent ponds or open marshes (Harding, 1992). In Ohio, the turtles have been reported uncommon in deeper or more exposed parts of lakes but frequently found in protected coves (Carr, 1952). In states bordering the Great Lakes the turtles are found in central marshes or sedge meadows of islands, peninsulas, or sandspits stretching into the large water bodies (Bleakney, 1963; Adams and Clarke, 1958; Petokas, 1986).

Female turtles avoid nesting in cool, shaded sites (Petokas, 1986). Wisconsin turtles nested in large (>6 ha.) contiguous grassland habitat in Ross and Anderson's study in 1990. 50.6% of the cover at the Wisconsin nest sites was comprised of grasses and Pennsylvania sedge (*Carex pensylvanica*) (Ross and Anderson, 1990). The females in Petokas' study in Ontario chose areas with little or no vegetation. However, nests were found in a clustered distribution, likely because of herbaceous cover along the perimeter of the chosen site where turtles could hide and survey the area before advancing into the open to seek a nest site (1986). They often choose disturbed sites. Petokas suggests that the turtles probably nested in available clearings, on sand and gravel bars, and on muskrat lodges or beaver lodges and dams prior to the modification of the landscape by man. However, all the females in his study chose areas disturbed by humans: tilled plots, cemeteries, a powerline right-of-way, and a road. No nests were on the available beaver dams (1986). Turtles have been known to cross open, sandy soil to nest in a tilled cornfield (Linck, et al., 1988).

Life History. Onset of nesting seems to be correlated with temperatures in April encouraging females to complete vitellogenesis. Nesting takes place within the period June 12-July 2 in central Wisconsin though it may vary by as much as two weeks in the same area. The turtles normally nest in the evening beginning when it is still light but rarely completing the nesting until after dark which takes an average time of 2.5 hours from first digging to leaving the nest (Congdon, et al., 1983; Linck, et al., 1988). Turtles in southeastern Ontario have been observed to average slightly less than 2 hours to complete nesting (Petokas, 1986). Because adult *Emydoidea* are fairly invulnerable to predators, they do not have to nest during the day like other turtles that are more easily preyed upon. Eggs are buried 2-3 inches below ground.

Clutch size is usually about 10-11 eggs (DeGraaf and Rudis, 1983; Pope, 1939; Congdon, et al., 1983) although clutches of 20 eggs have been reported for very large females (Petokas, 1986). As in other turtle species, clutch size varies with adult size, not adult age. Incubation period depends

on temperature but is relatively short as a selective advantage for a species nesting on ephemeral or unstable substrates such as sandbars and beaches. Incubation may take over 80 days at 24C but only 48 days at 30-32C (Ewert, 1979). *Emydoidea* exhibits temperature-dependent sexual differentiation that favors males if nesting habitats are cool with average incubation temperatures at less than 26^0C. and favors females if nests are in open habitats and incubation temperatures average warmer than 26^0C. Hatching begins in mid-to-late August in Wisconsin and continues into September.

Unlike most aquatic turtles, Blanding's turtles will eat food both in the water and out of the water (Pope, 1939; Vogt, 1981). *Emydoidea* are omnivorous (Graham and Doyle, 1977) and may take advantage of abundant sources of high nutrient foods when available. Blandings turtles have been observed consuming pondweed seeds (*Potamogeton* sp.), golden shiners, and brown bullheads where high nutrient levels from sewage effluent have stimulated the growth of high protein foods in Massachusetts (Graham and Doyle, 1977). Crustaceans and crayfish comprise about 50% of the diet, insects 25% and other invertebrates and vegetable matter 25% for turtles in New England (DeGraaf and Rudis, 1983) and Michigan (Lagler, 1943). Missouri turtles are primarily carnivorous, specializing in crayfish, followed by insects. They eat fish, fish eggs, and frogs as well, with small amounts of duckweed and algae always in association with animal food (Kofron and Schreiber, 1985). In Nova Scotia where crayfish are absent, the turtles eat dragonfly nymphs, aquatic beetles, and other aquatic insects as well as snails and some fish.

Blanding's turtles most often hibernate partially buried in the organic substrate of ponds and creeks. Five of the six overwintering turtles in the Wisconsin study used one of their summer activity centers for overwintering. Most moved from marshes, shallow ponds, and ditches to deeper ponds after September 1. The deeper ponds probably provide stable water levels during the critical overwintering period and a longer period of warmer water temperatures in early fall. Water temperatures ranging from 10-13 C., probably combined with changes in photoperiod, food supply, and rainfall, encourage turtle hibernation in Wisconsin between September 20 and October 22 (Ross and Anderson, 1990). Turtles in Missouri entered hibernation when water temperatures were 6.2C - 7.5C and were found in shallow marsh areas under 15cm mud below 9.5-21cm of water. At these temperatures the turtles would frequently change locations, moving as much as 13m (Kofron and Schreiber, 1985). In states south of Wisconsin, turtles have been known to hibernate beneath brush piles (Rowe and Moll, 1991) and leaves several feet from water (Conant, 1951).

Blanding's turtles live to be 30-40 years old and one individual in Minnesota is thought to have lived 77 years (Brecke and Moriarity, 1989). The longevity of Blanding's turtles is a life history characteristic of the K-strategist. Combined with delayed maturity, single clutches, and a short annual reproductive period, this species is banking on many productive years. According to Congdon, et al. 23-48% of the females in a population will reproduce in a given year (1983) and adults, barring death on the highway, can look forward to at least 15 years of reproductive activity. In this way, populations can be maintained through sufficient reproduction effort and an

occasional good year in spite of long periods of low recruitment due to nest failure, predation, or hatchling mortality (Petokas, 1986).

Terrestrial Movement. The Blanding's turtle is semi-terrestrial although the degree to which it is terrestrial in Wisconsin is poorly understood. Gibbons only found turtles on land between aquatic areas in April and in September as well as females in June (1968). Conant considers it to be unusual for turtles in Ohio to be more than 100 yards from the water (1951). However, Rowe and Moll found that terrestrial excursions were a significant part of Blanding turtle activity in Illinois (1991). In Eau Claire County, Wisconsin, researchers have noted terrestrial behavior including aestivation in deciduous forest in summer (Hay, pers.comm.).

Other than movement by females to locate nesting sites, Blanding's turtles may be said to have three other types of terrestrial movement, as noted by Rowe and Moll (1991). During reproductively-active periods, males may move long distances overland to locate mates. Secondly, short overland excursions to other water bodies are common and probably indicate explorations for improved ecological conditions or in response to social interactions. Thirdly, turtles have been observed to remain on land for several hours to several days perhaps to avoid cold water temperatures (Ross and Anderson, 1990; Rowe and Moll, 1991) or in aestivation, as in Eau Claire County, during hot summer weather.

Females do not usually nest in areas adjacent to their home ponds. In 1927, Brown observed that a female Blanding's turtle nested 0.5 mi (805m) from the water body that the turtle presumable inhabited in Ontario. Illinois females wandered overland for 5-17 days and up to 1670m away before nesting 650 to 900m from their home ponds (Rowe and Moll, 1991). Turtles traveled 200 to 1200m to nest in Massachusetts (Congdon, etal. 1983). Turtles in Nova Scotia were nesting 5 miles across a lake from their probable activity centers (Bleakney, 1963). Wisconsin females traveled 246m from non-nesting activity centers to nest on average

168 m from the nearest water body (Ross and Anderson, 1990). Congdon, et al. found females traveling up to 1115m. away from the nearest water body (1983). There is some evidence that Blanding's turtles exhibit nest site fidelity (Congdon, et al., 1983; Petokas, 1986).

Size of activity centers (where daily activities are carried out for several days at a time) do not appear to differ for male and female turtles and range from 0.1 ha to 1.2 ha (Ross and Anderson, 1990; Rowe and Moll, 1991). The activity centers may be quite widely separated however; up to 400-600m in some cases. Activity centers of females in Wisconsin overlapped with other females (average overlap: 26%) and juveniles (7.4%) as well as males (12%). Male activity centers did not overlap with those of other males (Ross and Anderson, 1990) although there is no substantiated evidence for territoriality in freshwater turtles. Daily movements have been recorded between 30m and 50m (Ross and Anderson, 1990; Rowe and Moll, 1991) although females may move as far as 95m in a day during nesting periods.

Management Concerns. Little data is available on the extent of habitat needed by *Emydoidea* populations. In the case of this turtle species, nesting site availability is more likely the limiting factor for population size than is wetland habitat. Population densities appear to range from 6 to 16 individuals per hectare in marshes (Gibbons, 1968; Graham and Doyle, 1977; Congdon, et al., 1983) and up to 55/ha in ponds (Kofron and Schreiber, 1985). Ross and Anderson found 27.5/ha in ponds in Wisconsin (1990).

Considering both the probability of an egg hatching and nest predation, the reality of recruitment is discouraging. A 1983 study in Michigan found the probability for survival to emergence to be only 0.18 (Congdon, et al., 1983). Trails left by females to and from nests are easily followed by predators, especially if the turtle marks the trail in any way for the nestlings to follow. In some turtle studies, 100% of the nests were predated (Petokas, 1986; Ross and Anderson, 1990). The primary predators are usually skunks, raccoons, or red fox.

Age class structures of *Emydoidea* populations that have been studied are highly skewed toward adults (Lagler, 1943; Gibbons, 1968; Graham and Doyle, 1977). Senescence of the populations has been observed in Missouri (Kofron and Schreiber, 1985), Illinois (Fogel, 1992), and Wisconsin (Hay, pers.comm.). Even prior to the 1950's young turtles were rarely reported (Carr, 1952). Perhaps recruitment is periodic to avoid problems of competition. The turtles are not aggressive nor territorial and perhaps have always lived in groups of primarily older adults. Cyclic flushes of juveniles may have been historically the result of cyclic predation due to environmental conditions inhibiting nest detection, decreased presence of predators, or population explosions of alternate prey during some years. It has been suggested that trapping techniques and locations may be missing the juveniles who do not share the same habitat as the adults. Whether the young turtles are absent or elsewhere is a question yet to be answered.

Habitat manipulation affecting the wetlands in which Blanding's turtles reside has been implicated in the depletion of populations in several states. Cultivation to the edge of the water and use of pesticides, especially those used to destroy aquatic vegetation (Kofron and Schreiber, 1985), as well as actual inundation or drainage of wetlands for agriculture or river channelization (Nyboer, 1992; Coffin and Pfanmuller, 1988) has reduced available habitat. Drawdowns to remove undesirable fish and pesticides sprayed on the exposed lake bottom when the turtles are already moving in late spring are detrimental to turtle survival (Nyboer, pers.comm.; Dorff, pers.comm.). Winter drawdowns have been documented in Minnesota to cause heavy mortality due to freezing (Dorff, pers. comm.).

Blanding's turtles are also suffering from losses due to collection for the pet trade, development of upland nesting sites, and road mortality. The turtles' habit of wandering long distances may be a limiting factor in their ability to adapt to the anthropogenic landscape. However, some researchers believe more nesting habitat has been created by human activities allowing populations in some areas to expand beyond presettlement numbers (Petokas, 1986). However, routes from wetlands to nesting areas are often hazardous for the turtles. Turtle tunnels under

existing roadways and sensitive routing of new and widened highways may be required to allow the animals to carry out reproductive activities. Habitat succeeding to shrubs creates a cooler incubation environment and skews sex ratios toward males. Nest site fidelity, if significant in this species, compels longterm protection of specific sites for existing populations. Genetic variability is most secure when populations are within ranging distance by males moving along wetland corridors.

Western Slender Glass Lizard (*Ophisaurus a. attenuatus* Cope)

Taxonomy and Status. There are six *Ophisaurus* species in North America. *Ophisaurus attenuatus*, the slender glass lizard, is a limbless lizard. It can be distinguised from a snake by its movable eyelids, external ear openings, and a rigid body. See Vogt (1981) for a description of the subspecies, *O.a.attenuatus*. The western slender glass lizard has no federal status but was listed in Wisconsin in 1979 as Endangered.

Range. The western slender glass lizard, *Ophisaurus a. attenuatus*, ranges from northwestern Indiana and southcentral Wisconsin through the Mississippi Valley to southeastern Nebraska and central Texas. In Wisconsin, at the northern edge of its range, the lizard occurs in scattered populations in the central part of the state but was probably historically more widespread in pine barrens, oak savannas, and sand prairies. The species has been found in LaCrosse, Monroe, and Jackson Counties as well as Adams, Juneau, Marquette, Waushara, Sauk, Columbia, and Dane Counties. Old records exist from Green Lake and Rock Counties (NHI, 1994). The northern prairie skink (*Eumeces septentrionalis septentrionalis*) inhabits the comparable dry, sandy soils in the northwestern section of the state (Casper, 1991).

Habitat. The habitat of the slender glass lizard is primarily oak savanna and sand prairie where the lizards are most often seen in clumps of sedge (*Carex pensylvanica*) in areas with lichens and small pines (Vogt, 1981). Hay (pers.comm.) reports them from short-grass prairies dominated by little bluestem (*Andropogon scoparius)* and often at or near habitat borders where adjacent habitats consist of oak savanna. In Kansas, they prefer a tall-grass prairie habitat (Fitch, 1965). Trauth found the lizards in Arkansas most often along grassy roadbanks (1984).

Pleyte studied the lizards in Waushara County, Wisconsin where 94% of all animals captured were found in oak openings and mowed grass areas along the roads (1975). In fact, 143 of Pleyte's 210 captures were in the roadside anthropogenic "habitat". He described the optimal habitat for the animal as having grass with not too much open sand, and cover (usually logs and brush) within 8 meters. The savanna groundcover was dominated by grasses (*Andropogon* spp., *Stipa spartea*, and others) but also included *Lupinus perennis*, and *Carex pensylvanica*. Pine plantations searched by Pleyte did not reveal glass lizards and were probably too shaded to have enough grass as well as having too high a percentage of open sand. The old fields searched appeared to be lacking in cover. The oak barrens studied were dominated by Hill's oak (*Quercus*

ellipsoidalis) with a large component of dead oak trees due to oak wilt. Pleyte assumed they had too much grass to be preferred glass lizard habitat. There are glass lizard sites in Wisconsin, however, that are pine plantations or grassy areas with young jack pines (NHI, 1994).

Fitch (1989) considers tall grass essential for the slender glass lizards. Even thick brome (*Bromus inermis*) fields in his Kansas study area had many lizards. Most of the lizards that Fitch studied were captured in the tall grass of former pastures. Because of their sleek shape the glass lizards move well through grass and likely take cover there when threatened. Slender glass lizards have been found in old fields and barrens in Wisconsin. After grazing is halted the tall grass habitat of early old field succession is rich in small mammals. When woody plants replace grasses, the numbers of small mammals decrease but good shelter for the lizards is available in the abandoned tunnels (Fitch, 1989).

Life History. Slender glass lizards exhibit a bimodal activity pattern. In April and May during the breeding season, five times as many adults were observed than in the fall in Arkansas (Trauth, 1984). Late May to early June would be the comparable period of activity in Wisconsin. A second peak of activity is in the fall as the animals prepare for hibernation.

Slender glass lizards may reach sexual maturity in two years in the southern part of the range (Trauth, 1984) but 2-3 years is more typical (Fitch, 1989). They mate in May or early June and six to seventeen eggs are laid in mid-June to early July in hollow stumps, abandoned mammal dens, or spaces under rocks and logs. During the incubation period, the female is very inactive, eating little and remaining with the clutch probably to turn the eggs or keep them moist (Fitch, 1965). The young hatch in August and enter hibernation in the fall. Pleyte found no activity of glass lizards after September 21 in Waushara County (1975). For hibernation, the lizards remain in the same area as they inhabited during the summer but move to below the frostline. Because they do not dig well, they are dependent for hibernation sites on the old burrows of mammals. They wriggle backwards into the loose soil of the burrow to protect themselves from attack during hibernation (Fitch, 1989).

The slender glass lizard becomes inactive at lower body temperatures than other lizards. For this reason, the lizards are most often found active in late afternoon or early evening, especially after rain showers. Pleyte found a marked preference for evening activity in Waushara County (1975). They are most active on days with temperatures between 70 and 77 degrees Fahrenheit (Pleyte, 1975; Fitch, 1989). Pleyte found no lizards above ground in Waushara County when the air temperature rose above 86 degrees Fahrenheit (1975).

Especially in loose soil habitats, the lizards spend extended periods underground in the summer where they burrow and forage for worms, snails, slugs, and other edible lifeforms of the soil. Olfaction plays an important role in *Ophisaurus* foraging (Fitch, 1989). Above ground, the lizards consume a variety of invertebrates. Caterpillars, beetles, snails, and spiders, particularly the wolf spider, are important foods early in the season (Pope, 1944; Fitch, 1989). Later in the

summer, katydids, crickets, and especially grasshoppers form the bulk of the diet (Fitch, 1989). Pleyte found grasshoppers, crickets, and scarabid beetles in the Waushara County animals' diet (1975). The lizards will also consume the eggs of ground-nesting birds and reptiles, young mammals, small snakes, and frogs. They daily forage within an area of only a few square meters (Fitch, 1989).

As prey, the slender glass lizard has been taken by red-tailed and broad-winged hawks (Ross, 1989), raccoon, skunk, and snakes. In Kansas, the red-tailed hawk is an especially important predator on this species (Fitch, 1965). If caught the lizard may shed its tail, but only once in its lifetime can it use this avenue of escape. Unlike snakes, the glass lizards do not have scutes or scales to move themselves forward and thus require debris or vegetation to push against. As a result, they are trapped on smooth surfaces such as highways. Unfortunately, the pavement-grass interface is attractive because prey is often more active here and the pavement offers a surface for basking. By avoiding pavement and predators, glass lizards can live to be 8 or 9 years old but Fitch did not find them to survive for more than a few seasons in Kansas (1989).

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In

this case, research into anthropogenic grasslands as glass lizard habitat and preserve size and habitat requirements minimizing predation would be most valuable to generate further informed land management decisions in regard to slender glass lizards.

Slender glass lizards have suffered habitat loss through succession to forest, plantations, and agricultural uses. Commercial insecticide spraying and the resulting accumulation of toxins from consumed invertebrates may adversely affect reproduction and survival (Vogt, 1981). Because the lizards are unable to cross roads, they are highly sensitive to habitat fragmentation. Croplands and wetlands are probable barriers to slender glass lizard dispersal.

Slender glass lizards have no obvious adaptations to fire although they inhabit a community dependent on fire. The lizards perhaps escape the fire underground. Prescribed burning may help the lizards by providing more escape cover through an increase in biomass as a result of the burn. Temporarily, however, the loss of vegetation may make them more visible and thus vulnerable to predation. In this case they may be limited to patches of habitat within a burned area such as gulleys, brush patches, woodland edges, or rock outcrops where vegetation remains until regrowth occurs. On a fire-managed prairie remnant in Kansas, Fitch found the lizards present only along the edges and in very low numbers compared to the old pasture sites he studied (1989).

Glass lizards can't live in heavily-grazed fields and are slow to recolonize new areas where prairie grasses have been restored (Fitch, 1965). As succession proceeds in abandoned fields, *Ophisaurus* numbers decline as brush and trees replace grasses. The combination of a slow breeding rate due to late maturity and, at most a single yearly clutch, plus the slow growth rate of young compared to that of other lizards leaves the slender glass lizard poorly prepared to recover from population losses (Fitch, 1965).

Home range sizes vary from 0.14 ha for juveniles to 0.44 ha for adult males (Fitch, 1989) though the ranges are without a focal point "den" and shift as the animal moves about, resting below the mat of groundcover when needed. Fitch found 400-700 individuals in a 7-ha site during a three-year MRR study (1989). Pleyte observed a population density of between 1.3 and 2.4 lizards per hectare, with home ranges between 2.0 and 0.7 hectare (1975). Fitch also reports 33.5 per acre with a home range of about 0.5 acre (1965). An estimate by Curtin of 400-480 acres for the size of habitat needed to support a minimum viable population of 400 glass lizards is the only such attempt to quantify preserve size for this species (1990).

Eastern Massasauga Rattlesnake (*Sistrurus catenatus catenatus* Raf.)

Taxonomy and Status. The family of pit vipers, Crotalidae, is composed primarily of the rattlesnake genera, *Crotalus* and *Sistrurus*. There are seven species or subspecies of *Sistrurus* distributed from Mexico and Texas through Kansas and into the northern Midwest. Two other subspecies of *S.catenatus*, the western massasauga and the desert massasauga, occur southwest of Wisconsin. The massasauga, by most accounts, entered the Midwest during the Hypsithermal about 5,000-7,000 years ago along the prairie corridor created during that warmer post-glacial period (Cook, 1992). The massasauga is a federal candidate for listing and is listed as Endangered or Threatened in most states within its range. The species is Endangered in Wisconsin. See Vogt (1981) for a description of the subspecies.

Range. *Sistrurus c.catenatus* was first described in 1818 from prairies near Kansas City, Missouri (Beltz, 1990). The subspecies ranges from Missouri and Iowa with a few stations in southeastern Minnesota to southern Ontario, New York, and Pennsylvania (Beltz, 1990). In the 1800's the snakes could be found throughout Wisconsin below the Tension Zone. The Wisconsin Herpetological Atlas reports occurrences of the animal in 16 counties from Pepin and Wood to Walworth and Racine (Casper, 1995). Reliable records indicate isolated populations currently in Buffalo/Pepin, Jackson, Juneau, Walworth, and Trempealeau/LaCrosse counties (Casper, 1992).

Habitat. Habitat of the eastern massasauga is often composed of two communities, the wetland habitat and a drier upland area. In Minnesota and extreme western Wisconsin today, the animal is primarily restricted to river bottom forests and adjacent fields (Land and Karns, 1988; Vogt, 1981). In other states and central Wisconsin, the massasauga continues to inhabit prairie marshes (Christansen and Bailey, 1990), swamps, bogs and fen peatlands with low shrubs. In the Chicago area, the rattlesnakes are found in the ecotone between woodland and wet prairie, areas of clay hardpan with uplands of scattered shrubs, or savanna-like communities where sunlight provides for a grassy, herbaceous layer (Mierzwa, 1992). In Ontario, the snakes have been found to inhabit lowland conifer forest (Weatherhead and Prior, 1992). Seasonal wetlands are critical to the species and fens and marshes are preferred over swamps. They prefer habitat with canopies less than 10m in height (Hay, 1992).

Seasonal movements of the massasauga appear to vary with locality. In Missouri, a study showed the animals to be in wet prairie in spring, moving in summer to drier uplands and old fields, and then in fall returning to the wet prairie and associated marshes to overwinter (Siegel, 1986). Telemetry studies on Bruce Peninsula in Ontario tracked the animals and found that they used upland areas with low tree heights or shrubs in the spring but avoided grass-dominated open areas in preference to fairly closed marshes, shrubby swamps, and fens in the summer (Hutchinson, etal., 1993). In the fall, the snakes either remained in those wetland habitats or found hibernation sites in nearby white cedar (*Thuja occidentalis*) swamps (Weatherhead and Prior, 1992). In central Wisconsin where the snakes are being tracked in the upland areas of Necedah NWR, individuals are known to travel one-third mile (0.53km) or more from wetlands

into the surrounding upland areas (King, R. pers. comm.).

The massasauga uses a combination of open, sunlit areas such as openings in conifer forest or old field (Weatherhead and Prior, 1992) and shady woodland or shrubland for thermoregulation. Both uplands and wetlands provide opportunity for foraging. Snakes have been found to move 9.1m per day in Pennsylvania with home ranges of slightly less than 1 hectare (Reinart and Kodrich, 1982). In Ontario, however, snakes move an average of 56m per day (Weatherhead and Prior, 1992). The Ontario researchers found activity ranges of 25 hectares with the females having smaller ranges than the males.

Unlike many other snakes, massasaugas hibernate singly. Areas with the water table near the surface are chosen for hibernation where they may spend the winter underwater. There is some evidence of site fidelity to overwintering locations (Hay, 1992). In Wisconsin and Missouri, massasaugas overwinter at or near the water level in crayfish burrows in bottomlands as well as mammal burrows or sawdust piles (Seigel, 1986). "The presence of crayfish burrows for hibernating may be a very important factor limiting the habitable areas within the range of the massasauga" (Vogt, 1981). Farther north, in Michigan, the snakes use rock crevices and tree root systems for hibernation (Moran, 1992). Tree root hollows are also used for hibernation in swamp forests in Ontario as well. They may move over 2.4km between summer activity areas and hibernacula (Hay, 1992).

Life History. Massasaugas emerge in late April during spring flooding in Wisconsin and move to upland areas as waters recede (Oldfield and Moriarity, 1994). During spring and fall they are diurnal but restrict themselves to crepuscular and nocturnal periods in summer (Oldfield and Moriarity, 1994). Massasaugas reach breeding age in 2-3 years. They breed in spring primarily, but fall breeding has also been reported. There is some evidence of a biennial reproductive cycle (Reinert, 1981). Three to twenty live young are born in late August in mammal burrows or under fallen logs (Oldfield and Moriarity, 1994).

The snakes feed primarily on mice, shrews, and voles (Vogt, 1981; Christansen and Bailey, 1990; Oldfield and Moriarity, 1994), though they will consume other cold-blooded vertebrates if necessary, such as garter snakes, spring peepers, or leopard frogs. In the Chippewa River bottoms, more than 85% of the diet is voles (Vogt, 1981). Massasaugas are themselves prey for hawks, owls, large wading birds, skunks, racoons, and foxes. The loggerhead shrike has been known to prey on the massasauga (Chapman and Casto, 1972).

Management Concerns. In an effort to provide land managers with available information on the possible response of the species in question to land management activities, the following may be drawn from a variety of sources. This discussion is not exhaustive nor is it meant to be prescriptive. Where studies are lacking, current knowledge depends heavily on the educated observations of biologists most familiar with the species and others of its kind. In this case, research into the location of the snakes throughout the season would be most valuable to generate

further informed land management decisions in regard to massasauga rattlesnakes.

Wetland loss has been the greatest threat to massasaugas. In areas where the wetlands are protected, adjacent upland areas visited by the animals need protection as well. The snakes prefer low shrubby habitat over forested habitat. Forest succession due to timber management or natural processes threatens habitat (Hay, 1992). Protection of information on massasauga sites helps to minimize collection pressures and losses to willful destruction suffered by this species. Massasaugas won't hibernate in flowages or other flooded areas. Also water level control is a threat to hibernating snakes. Drawndowns may cause the animals to freeze to death (Hay, pers.comm.).

Frequent burning of swales in Iowa has resulted in declines in the species (Beltz, 1990), mortality due to late season burning has been observed in Missouri, and Illinois researchers have observed losses from summer mowing (Hay, 1992). Hay recommends controlled burns be performed in the spring before emergence and mowing be conducted when temperatures are cool enough to avoid injuring basking snakes. Also, rotation of management between burning and mowing on management units that include a variety of habitats may help maintain a higher prey base and maintain adequate habitat for normal massasauga activities (Hay, 1992).

Sharp-Tailed Grouse (*Pedioecetes phasianellus*)

(*Tympanuchus phasianellus*)

Taxonomy and Status. Grouse belong to the order Galliformes which also includes turkeys, pheasants, chachalacas, quails, and partridges. There are six representatives native to Wisconsin: wild turkey, spruce grouse, ruffed grouse, sharp-tailed grouse, greater prairie chicken, and the northern bobwhite quail. The ring-necked pheasant and gray partridge are Gallinaceous birds introduced to the state. Like the prairie chicken, the sharp-tailed grouse is native to prairies. The grouse has no federal status but is of special concern in Wisconsin where the birds primarily exist in areas of managed habitat.

Range. The sharp-tailed grouse ranges from Alaska and northern Canada south and east into the Plains states, Wisconsin, Michigan, Ontario, and western Quebec. In Wisconsin it inhabits counties in the northwestern and central areas of the state as well as a few northeastern counties. Douglas and Burnett Counties have populations of the grouse as do to a lesser degree Jackson, Wood, and Clark in Karner blue range. Records exist from Polk and St.Croix Counties as well (Faanes, 1981).

Habitat. Sharp-tailed grouse habitat is generally the pine-shrub-grassland community, savanna, or brush prairie. Grouse habitat in Douglas County, for instance, is mixed grasslands with scattered oaks, aspens, or shrubs and patches of jack pine (Faanes, 1981). The birds use different areas depending on the stages of mating and nesting. Preferred courtship sites are slightly

elevated clearings such as ridges or grassy knolls in meadows or fields with good visibility. Males may visit these areas for ten months of the year. The area must be very open. Tall conifers within 1/2 mile will result in the eventual abandonment of the site as a dancing grounds (Shively and Temple, 1994).

Nesting sites will be chosen within 1/2 mile of the dancing grounds in grassy areas with dense cover. The chicks are raised in areas with young trees or shrubs for shade but with clearings for an abundance of insects. Later in the summer the brood moves back into denser cover. Wintering areas are in mixed forests where the birds can feed on woody browse. Suitable habitat has been lost over the years in the southern part of the state due to agricultural conversion but logging created habitat in the North. Habitat has decreased however, since the 1930's when fire suppression combined with forest regrowth and pine plantations left the birds in isolated remnant populations (Shively and Temple, 1994). Currently the birds are maintained on managed state wildlife areas and adjacent private lands that consists of about 1,000 square miles of sharptail habitat. The grouse travel extensively and may move 2-3 miles per day and 10 miles seasonally.

Life History. Young male sharptails may begin to establish breeding display territories during their first fall. They will return to these leks year after year in early spring to perform the elaborate and competitive courtship display rituals each morning and evening to attract females. After mating occurs the females do not remain with the males but leave the dancing grounds to locate nest sites. There are no pair bonds created in this promiscuous mating system where presumably, there is no advantage for the male to help raise the young. On each lek there is normally a dominant male who mates with most of the females. In one study, a single male grouse performed 17 of 24 matings (Ehrlich, et al., 1988).

The female lays one egg per day until the 10-14 egg clutch is complete. The nest is usually a lined shallow depression in grass or under a shrub. Incubation requires 23-24 days. The young begin to fly about 10 days after hatching and are fully independent in 6-8 weeks. Young sharptails may move several miles from their hatching sites. In winter the grouse form mixed-sex flocks of usually 10-35 birds (Ehrlich, et al., 1988).

Sharp-tailed grouse young are highly insectivorous but the adults eat primarily vegetative matter such as weed seeds, waste grain, wild forb leaves and sprouts in spring; flowers, leaves, and fruits of many green plants in summer; seeds and fruits of trees and shrubs in fall; twigs and buds of paper birch, aspen, and hazel in winter. The adults augment their diet with beetles, grasshoppers, crickets, and caterpillars in summer.

Management Concerns. To maintain the shrubby, open habitat required by sharp-tailed grouse, management often consists of a combination of mowing, burning, herbiciding, clearing, and bulldozing. Many Karner blue butterfly sites on public lands are already being managed for sharptail grouse. Areas of Burnett County, for instance, have been managed since the 1950's for brush prairie and support healthy populations of Karner blue butterflies (Evenson, D.

pers.comm.). Both species are creatures of a dynamic, disturbed landscape and require a diverse habitat though on different scales.

Loggerhead Shrike (*Lanius ludovicianus*)

Taxonomy and Status. Shrikes are in the family Laniidae. Only two species of shrikes occur in North America, the loggerhead shrike and the northern shrike, *L.excubitor*. Elsewhere in the world are 315 additional species. The loggerhead shrike is considered relatively stable west of the Mississippi but is declining in the East (Fruth, 1988) and is under review for listing by the U.S. Fish and Wildlife Service. The bird was listed as Threatened in Wisconsin in 1979 and reclassified to Endangered in 1982.

Range. The loggerhead shrike ranges from the Pacific to the Atlantic coast and from southern Canada to Mexico. Approximately the southern half of the breeding range constitutes the wintering range. Although 11 subspecies have been described, the AOU recognizes only 8 subspecies (Fruth, 1988). The Wisconsin subspecies is *L.l.migrans* which breeds from southern Manitoba to eastern Texas. Eastward, the breeding range intergrades with subspecies *L.l.ludovicianus* along a line through Louisiana, Tennessee, West Virginia and Maryland. To the north the shrike was formerly a resident of the Maritime Provinces but is now found only in limited numbers in Quebec and Ontario. Populations have declined for several decades throughout the species' range in the Midwest, New England, and the mid-Atlantic states. The Breeding Bird Survey showed the upper Midwestern shrike population to be declining by 6% per year from 1966-1987 (Hands, et al., 1989).

The loggerhead shrike was formerly considered a common summer resident throughout Wisconsin except for the northeastern and northcentral regions. Populations of the shrike began declining in the 1930's and suffered another precipitous drop in the 1960's. Between 1979 and 1987, the average number of breeding pairs per year in Wisconsin was 4.0. In 1987, five pairs were reported in the state (Fruth, 1988). These birds were found nesting in central and westcentral Wisconsin and Door County (Hallowell and Gieck, 1987).

Swengel reported a loggerhead shrike in Burnett County in 1991 (pers.comm.). That same year a bird was reported from Waupaca County and another from Forest County. A nesting pair was reported from Green County. Oconto County produced two nests and 14 birds were seen in that county through the nesting season (Soulen, 1992). The following year shrikes were reported from Green, Iowa, Rock, and Taylor Counties (Soulen, 1993). Two pairs nested in Oconto County in 1993 and one bird was reported from that county in 1994 (Soulen, 1994).

Habitat. Shrikes are birds of open country though they require shrubs and low trees for nesting and perching such as those found in native savanna and upland shrub carr. Nests are built in a variety of trees, shrubs, and vines at heights ranging from 1.3 feet in shrubs to 25 feet in trees

(Hands, et al. 1989). In Wisconsin, nests are typically 4-8 feet above the ground (Robbins, 1991). Prairies and deserts (in the West) are the natural habitat of shrikes. In the altered landscape, they are found using pastures and old fields containing scattered trees, shrubs or adjoining hedgerows. In Wisconsin in recent years, shrikes have been reported nesting adjacent to marsh habitat and in hedgerows surrounded by corn fields or near housing developments (Fruth, 1988).

Trees such as hawthorn (*Crataegus* spp.), locust (*Robinia pseudoacacia*), or wild plum (*Prunus americana*) that the shrikes prefer for nesting have thorns on which to impale their prey. Structural qualities of the habitat, however, are as important as the plant species, providing concealed nest sites and suitable perches. Habitat in western Canada often includes dense willow (*Salix* spp.) or clumps of thorny buffaloberry (*Shepherdia argentea*) whereas hawthorn (*Crataegus* spp.) is commonly used in eastern Canada (Telfer, 1987). In Minnesota, shrikes prefer to nest in isolated red cedars (*Juniperus virginiana*) amid agricultural fields (Brooks, 1988). In South Carolina, shrikes prefer to nest in red cedar and enjoy greater nesting success there than in other trees (Gawlik, 1988). Red cedars provide greater protection from nest loss due to adverse weather than do deciduous trees or shrubs. Red cedar as well as wild grape are also commonly used for nesting in Wisconsin.

Shrikes nesting in scattered shrubs or trees appear to suffer fewer losses due to predation than do those nesting along fencelines or hedgerows (Yosef, 1992). In Alberta, however, scattered shrubs were less often occupied than were shrubs stretching along the margin of a railway embankment (Prescott and Collister, 1993). Dead stems or utility wires for perches are a necessary component of the habitat.

Shrikes find their prey in grass, however the type of grassland preferred appears to vary with availability. Active pasture often offers the best opportunity in the context of row crops or lawns (Brooks, 1988; Novak, 1986; Gawlik, 1988). Although Telfer reports the birds across Canada hunting over closely-grazed pastures (1987), in Alberta the birds preferred to nest in areas of taller undisturbed grasses (20.0cm vs. 15.8cm) where short grass areas were the result of heavy grazing (Prescott and Collister, 1993). Although short grasses improve prey capture, such areas contain fewer invertebrates.

Shrikes are the only songbirds that regularly prey on other vertebrates. They typically perch on branches, fences, or telephone wires for a view of the surrounding open terrain and are known for the unique behavior of impaling their prey on thorns or barbed wire in order to tear off small pieces. In early morning and at dusk they actively hunt by making frequent trips to the ground from perches 0.5-6 feet high. During the rest of the day they wait and observe from higher posts where they can detect prey from up to 150 feet (Fruth, 1988). During the breeding season they are primarily insectivorous, capturing mostly grasshoppers and scarab beetles (Mizell, 1993). During the winter vertebrates become the main prey including small birds, lizards and snakes, mice and

shrews (Hall and LeGrand, 1989).

Life History. Loggerhead shrikes arrive in Wisconsin in early April, find mates, and nest from April 21-July 5 producing 4-6 eggs (Robbins, 1991). Incubation takes an average of 17 days with another 17-21 days for fledging occurring in early June. Robbins reports that double-brooding (April and July) may be possible for this species (1991). Often the youngest nestling perishes from starvation. Predation by snakes can contribute to further losses. Adverse weather has also been implicated as a contributor to nest losses. Fledging success is 50-88% in Missouri (Kridelbaugh, 1983) and Minnesota pairs produce 3-4 fledglings per female (Brooks, 1988). The shrikes are most easily observed in June and July when both parents are feeding the nestlings. After fledging, the male is primarily responsible for care of the young (Hall and LeGrand, 1989). The shrikes defend a territory of about 3.14ha in Alberta (Prescott and Collister, 1993) and from 1ha to 12ha in Missouri (Hands. et al. 1989). Territory size varies with quality of habitat and nesting stage, being largest during incubation. Two to three clutches are common in the southern states. The birds may begin leaving in August and are usually gone from Wisconsin by October 10 (Robbins, 1991).

Management Concerns. Several explanations for the decline of the species since the 1930's have been proposed including loss of breeding habitat, mortality on the wintering range, and poor reproduction. Numerous researchers have concluded that the shrike populations are not limited by availability of breeding habitat (Brooks, 1988; Gawlik, 1988; Kridelbaugh, 1983). In contrast, Prescott and Collister in Alberta found preferred habitat with tall grass to be at a premium in a context of heavily-grazed pastureland (1993) and suggested management for short grass to be contradictory to the needs of the shrikes in southwestern Canada.

Various studies of reproductive success have concluded that the shrike populations are reproducing normally (Gawlik, 1988; Kridelbaugh, 1983). Conversion of grasslands to row crop agriculture in the southern states (Kridelbaugh, 1983) has created dramatic increases in populations of Icteridae that feed primarily on grain (Brooks, 1988). Competition with burdgeoning European starling populations in particular, make life difficult for shrikes in some areas (Novak, 1986). Mortality during overwint ering probably contributes to losses in the northern loggerhead shrike populations. The resident shrikes in the southern states defend winter territories making it harder for the migratory birds to find hunting grounds (Gawlik, 1988).

Because of the position of shrikes near the top of the food chain and habit of foraging along the edges of fields where pesticides have been applied (Novak, 1986), loggerhead shrikes, particularly the immature birds, are vulnerable to the accumulation of residues from ingested toxins. DDT residue concentrations have been found to be higher in loggerhead shrikes two years after application than during the first year (Fruth, 1988). Researchers have implicated ground beetles as an important source of contaminants ingested by shrikes (Anderson and Duzan, 1978).

Kirtland's Warbler (*Dendroica kirtlandii* Baird)

Taxonomy and Status. The Kirtland's warbler, *Dendroica kirtlandii*, "The Jack Pine Warbler", is probably the rarest member of the wood warbler family, Parulidae. Because of its habitat specificity and endemism, it has been under intense scrutiny since it was first discovered. A good field guide can offer a description of the species, however Kirtland's warblers are best located by listening for the singing males in potential habitat. The song of the warbler is loud and the singers usually persistent. Most people can hear the singing male for at least 0.2mi (0.3km). A suspected individual should be verified by a photograph or identification by a qualified observer. The Kirtland's warbler is critically imperiled globally and listed federally as Endangered. In Wisconsin the species is of special concern because it has been found a few times in the state but only as a nonbreeding species. The Kirtland's warbler requires jack pines barrens as its breeding habitat.

Range. Jack pine, *Pinus banksiana*, did not enter the upper midwest until the retreat of the Wisconsin glaciers 10,000 years ago. Prior to that time, jack pine was abundant in the southern Appalachians and the southeastern coastal plain where presumably the Kirtland's warbler resided in its chosen habitat, migrating in winter to the nearby Bahama Islands. Recent pollen analysis has indicated that jack pine was absent from the sand outwash plains beyond the glaciers in the Midwest, so the warbler is thought to have entered the area from the southeast with the retreat of the glaciers and the advance of *Pinus banksiana* (Mayfield, 1992).

The Kirtland's warbler was first collected in 1851 on its migration route near Cleveland, Ohio and described in 1852 (Harrison, 1984). In 1903, the breeding habitat of the species was identified. The Kirtland's warbler is endemic to an area that today is about 120 by 160 km in northern lower Michigan. 485 singing males were counted there in 1993. Michigan has conducted censuses for the bird since 1951 and set aside state-owned lands for the warbler beginning in 1956. After the population declined by 60% between 1961 and 1971, yearly censuses were begun in that state (Weinrich, 1994).

Ninety percent of nests found since the first Michigan find in 1903 have been in the drainage of the AuSable River in western Oscoda County, Michigan (Mayfield, 1992). Today, there are approximately 134,000 acres of jack pine designated for Kirtland's warbler nesting habitat in Michigan (Mangold and Richter, 1994). The species is continuing to increase in numbers in Michigan due to intensive recovery efforts including habitat creation and cowbird control (Weinrich, 1994). Areas of likely habitat have been checked since 1977 in several states and provinces. Warblers were found in Ontario, Quebec, and Wisconsin but no nests have been found outside of Michigan (Weinrich, 1994). There are nine verified records of the Kirtland's warbler from Wisconsin from the mid-1880's to 1977. All these birds were found in May in the eastern half of Wisconsin and only two were in counties with jack pine, giving credence to the belief that they were probably migrants. During that period, the only record near Karner blue butterfly range

was from Waushara County in 1971 (Tilghman, 1978).

In 1978, the Wisconsin Department of Natural Resources conducted a search for the warbler in the state. Two males were found in a 90-acre jack pine stand in Jackson County where they had set up territories and remained from at least June 10 to July 31 (Tilghman, 1978). An unconfirmed sighting was also reported in northern Juneau County that year (Robbins, 1991). One and perhaps three males were heard in the same area of Jackson County in 1979 (Hale, 1979). One warbler was heard in Jackson County in 1980 (Tessen, 1980). No further evidence of Kirtland's warblers was reported until 1988 when six males were observed in Douglas, Jackson, and Washburn Counties. A single male was heard in Douglas County in 1989 (Robbins, 1991). One bird was heard through June, 1991 in Jackson County (Soulen, 1992) and one bird was reported from Washburn County in 1992 (Soulen, 1993). The likelihood of the Wisconsin males finding mates is quite slim (see below). However, it does indicate that suitable nesting habitat exists in the state.

Habitat. The nesting habitat for this warbler is quite specific and is a major limiting factor for the species. Jack pine must predominate and be between 1.3m and 6.0m in height (Harrison, 1984; Morse, 1989; Probst and Weinrich, 1993), though Ryel (1981) has found that the birds no longer use areas when trees are taller than 4.9m and Probst and Weinrich found that populations begin to decrease in an area with trees reaching 3.8m (1993). All the nests found during the 1993 Michigan census were in areas of young or middle-aged habitat (Weinrich, 1994). Morse (1989) and Mayfield (1992) have found birds in areas with trees from six to twenty-two years old. The birds appear to prefer naturally-grown jack pines over planted trees (Ryel, 1981) though 34% of the males found in the 1993 census were in areas specifically planted for warbler habitat (Weinrich, 1994). Morse (1989) reports that the birds sometimes nest in red pine plantations where they have moved from adjacent jack pine habitat within the Michigan breeding range. Large stands are required, at least 80 acres and perhaps 200 acres or more (Harrison, 1984). This is quite large for warblers, however the habitat includes less vegetation than do most forests inhabited by warblers (Mayfield, 1992). The low

ground cover typical of this sandy soil habitat is most naturally maintained by fire. The 1980 Kirtland's warbler survey found three-quarters of the singing males on wild fire sites (Ryel, 1981). Controlled burns have become part of Kirtland's warbler management in Michigan.

Nesting territories have been recorded to range from 0.6ha to 6.7ha (Mayfield, 1992). The Kirtland's warbler recovery team recommends 12ha of young jack pine for a breeding pair (1976). Typically an area is used for only ten to twelve years but use may range from six to nineteen years (Mayfield, 1960). The population generally builds for 3 to 5 years after colonization, levels off for 5 to 7 years, and then declines rapidly. Tree cover in newly-colonized stands is approximately 15-20%, during the years of highest warbler density tree cover may reach up to 60%, and tree cover typically exceeds 60% during the period of decline (Probst and Weinrich, 1993). Kirtland's warbler habitat in Michigan occurs on Grayling sand soils (Mayfield,

1992). The most similar soils in Wisconsin are the Plainfield loamy sands of central Wisconsin and the Vilas, Omega, and Hiawatha sands of northern Wisconsin (Tilghman, 1978).

Life History. Male warblers usually arrive on the nesting grounds between May 3 and May 20 with females arriving a few days later. Female Kirtland's warblers build their nests on the ground which is unusual for *Dendroica*. The nest is typically hidden in thick grass, sweet fern, or blueberries under the jack pines and the sandy soil allows the warbler to recess the nest in the ground (Morse, 1989). Egg-laying begins in late May. Females incubate generally 5 eggs for fourteen days which is the longest incubation time for a North American warbler. The eggs hatch in mid-June. Males feed the females and assist in feeding the young (Harrison, 1984). The nestlings fledge by the ninth day after hatching. The young may be cared for by the parents for up to 44 days after leaving the nest but usually parental feeding ceases by the fifth week (Mayfield, 1960).

The warblers eat a variety of insects from the ground, air, or pine foliage. They tend to hover at the ends of branches and pluck insects out of the pine needle clusters. They also eat berries (Woodard, 1980). There is some evidence that nesting will be unsuccessful in areas that can suffer below-freezing temperatures in early June, thus restricting the species to only the most southern jack pine areas in North America (Mayfield, 1992).

The small area inhabited by Kirtland's warblers is problematic for the species. By missing the Michigan habitat by the width of two counties when returning northward in the spring, a warbler may not find a mate and lose the opportunity to produce a brood (Mayfield, 1992). As a species of successional habitat, the Kirtland's warbler is inclined to occupy new areas. This can also lead to difficulties in find mates. On the positive side, the species is semi-colonial. Clusters of two to thirty pairs have been found separated by substantial distances of similar habitat (Morse, 1989). Although yearling male Kirtland's warblers may be wide-ranging in their search for territories, females tend to nest closely to the area where they were hatched (Tilghman, 1978). Ecologists speculate that it is this semi-colonial breeding behavior and site fidelity that has kept the species from extinction thus far (Ehrlich, et al., 1988). In the fall, the majority of Kirtland's warblers have left the state for the winter migration to the Bahamas by the first week of September though some remain until early October. The hatching year young leave before the adults, having finished the final molt by September (Sykes, et al., 1989). The overwintering survival rate for adults is about 65% but is much lower for yearlings (Harrison, 1984).

Management Concerns. Should introduction of the species to sites outside Michigan be conducted as recommended by the Kirtland's Warbler Recovery Plan, jack pine management practices are generally suitable for provision of habitat for Kirtland's warblers (Tilghman, 1978). In Michigan, management of Kirtland's warbler habitat consists of logging, burning, and planting on a rotational basis to provide a constant supply of early-to-mid successional jack pine as required by the birds for nesting habitat (Mangold and Richter, 1994).

Studies of cowbird parasitism between 1951 and 1971 found that half to three quarters of the Kirtland's warblers nests were parasitized by cowbirds (Morse, 1989). The warblers have no mechanism against nest parasitism. Since 1972, Michigan has been removing an average of 4,025 cowbirds annually from Kirtland's warbler habitat (Mangold and Richter, 1994).

Phenology Charts

Butterflies

The elfins are alike in their yearly life cycles. Both are possibly found where Karner blue butterflies reside. The frosted uses wild lupine as its host plant. Henry's elfin uses a plant most likely of the heath family. Henry's nectars at violets, puccoons, and perhaps, rock cress. Gorgone checkerspot and tawny crescent are of the same family. Both uses plants of the Compositae: asters for tawny and asters or *Ratibida pinnata or Helianthus* sp. for gorgone. The checkerspot also chooses yellow-orange flowers for nectaring; i.e. puccoon, orange hawkweed, rock cress. The latter two butterflies are less likely to be found in the same microhabitats of the barrens landscape as are the Karner blues. The tawny crescent, for the most part, inhabits moist areas.

	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	WINTER
FROSTED ELFIN	P	ADULT	Larvae in lupine flowers, eating flowers, pods					Pupae
	Eggs laid singly on flower buds. Pupae in loose cocoon in litter at base of plant or underground.							
HENRY' ELFIN	P	ADULT	Larvae feed on buds and leaves of host shrub					Pupae
	Eggs laid on flower buds. Probably (?) in litter at base of host plant.							
Gorgone Checker-Spot	P	ADULT	P	ADULT	Larvae feed together on leaves			Larvae
	Pupae where? Eggs laid clustered under leaves. Where?							
Tawny Crescent	Larvae	P	ADULT	Larvae in communal webs under leaves				Larvae
	Eggs laid in groups under leaves. Probably (?) at base of host plant.							
Karner	Eggs	P	AD	P	ADULT	Larvae feed on leaves		Eggs

Plants

	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	WINTER
ROUGH SEEDED FAMEFLOWER				FLOWERING				
		Plants must be older than three years to flower						
OVAL			FLOWERS				SEEDS MA-TURE	
MILKWEED		cf. Diptera pollinators						
SAND VIOLET	FLOWERING		Mature Seeds	Lepidoptera or Hymenoptera pollinators Ant Dispersal				

Folded-wing Skippers

These skippers live on grasses, primarily little bluestem. Leonard's skipper is known to use big bluestem, needlegrass, dropseed, and others . Within the barrens landscape, these skippers are not likely to be found where Karner blues reside on wild lupine because of the dominant grasses needed by the skippers. The skippers visit flowers for nectar. The cobweb has been observed on rock cress, wood betony, and violets. The dusted skipper may be found on downy phlox with the phlox moth and nectars at wild lupine and violets as well. Leonard's skipper chooses purple flowers: asters and *Liatris* spp.

	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	WINTER
Cobweb Skipper	P	ADULT	Larvae in base of grasses and feeding on leaves					Larvae
	Pupae in debris. Eggs laid singly on leaves. Aestivation underground. Center of grass plant.							
Dusted Skipper	P	ADULT	Larvae in leaf tents 1+ ft. up in grasses					Larvae
	Pupae 1-3" up in plant. Eggs laid singly on leaves. At plant base.							
Leonard's Skipper	Larvae			P	ADULT	Egg...		Larvae
	Where? Pupae cf. in debris. Eggs laid singly on leaves. Where?							

Spread-Wing Skippers

These skippers are likely to be found at Karner blue microsites. The Persius lives on wild lupine. The mottled duskywing requires the shrubs, *Ceanothus ovatus* or *C. americanus.* Nectar sources for these species are less well known than the skippers mentioned above. The mottled has been observed using verbena and *Lithospermum* sp.

	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	WINTER
Persius Dusky-wing	Larvae	P	ADULT	Larvae in rolled leaf nests, feeding on leaves				Larvae
	Pupae in cocoon.	Eggs laid singly under leaves.				In leaf shelter.		
Mottled Dusky-wing		P	ADULT	Egg....	ADULT	Larvae in leaf nests		Larvae
	Pupae in cocoon.		Eggs laid singly on flower pedicels.			In leaf shelter.		

Birds

Sharp-tailed grouse consume a variety of plant matter. Shrikes nest in trees or shrubs with spines such as hawthorn, wild plum, or locust but also use red cedar. Kirtland's warblers usually require jack pines.

<table>
<tr><td></td><td>APRIL</td><td>MAY</td><td>JUNE</td><td>JULY</td><td>AUG</td><td>SEPT..</td><td>WINTER</td></tr>
<tr><td rowspan="2">SHARP TAILS</td><td>Courting</td><td colspan="3">Hatch Fledge</td><td></td><td></td><td>establish</td><td>Mixed</td></tr>
<tr><td>Lay</td><td>Incubate</td><td>Nestling</td><td colspan="3">Independent</td><td>leks</td><td>sex flocks</td></tr>
<tr><td>Food:</td><td colspan="2">grain, seeds, sprouts,forbs</td><td colspan="4">grasshoppers, beetles, caterpillars, flowers</td><td>seeds,fruit</td><td>twigs,bud</td></tr>
<tr><td rowspan="3">SHRIKE</td><td>Arrive</td><td>Nesting</td><td colspan="3">Incubation</td><td>Fledge</td><td></td><td></td></tr>
<tr><td>Mate</td><td>4-8 ft. up</td><td colspan="2">Egg laying</td><td>Nestling</td><td colspan="3">Migrate by October 10</td></tr>
<tr><td colspan="8">INSECTIVOROUS: Beetles, grasshoppers, etc.</td></tr>
<tr><td rowspan="3">KIRTLAND'S WARBLER</td><td colspan="2">Arrive, mate</td><td colspan="3">Fledge</td><td colspan="3">Young leave</td></tr>
<tr><td>Ground Nest</td><td>Lay</td><td>Incubate</td><td>Nestling</td><td>Parental Care</td><td colspan="3">Sept: Parents migrate</td></tr>
<tr><td colspan="8">Semicolonial nesting. Food: berries, insects, esp. from pine needles</td></tr>
</table>

Additional Invertebrates

The Phlox moth larvae live on downy phlox. The red-tail leafhopper lives on prairie dropseed.

	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	WINTER
PHLOX MOTH		P	ADULT	Egg..Larvae	Pupae			Pupae
	cf. underground							
TIGER BEETLE	Yr.1: Eggs Larvae (underground during heat) Larvae							
	Yr. 2: Larvae Pupation Adults (3 cm burrows for heat, rain, etc.) Adults							
	Yr.3: Adults Eggs (only 3-5 mm into the soil)							
	Larvae live in burrows at least 15 cm deep							
Red-tail Leafhopper	Egg... Nymph		ADULT	Nymph	ADULT	Egg		Egg
	Nymphs remain on grasses			Eggs are deposited in plant tissue				

Herptiles

The wood turtle nests communally in sandy, sunny open areas. The Blanding's turtle uses open grassland habitat for nesting and lays eggs 2-3" below the soil surface. Both turtles are omnivorous, but the wood turtle makes greater use of vegetation outside of the wetland area. The massasauga also spends large amounts of time outside the wetland. The slender glass lizard has very specific habitat needs to consider.

	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	WINTER
WOOD TURTLE	Mating at 14+ years old		Nesting		Emerge		Hibernation under ice, log jams, muskrat burrows	
	Forage in upland woods, meadows for forbs, leaves, berries, insects, worms < 1/4 mi. from river							
	Little time spent in water during the active season.							
BLAND-ING'S TURTLE	Mating		Nesting		Young emerge and go to water		Hibernation in mud below water	
	Females travels upland 1/4-1/2 mi to nest							
	Shallow ponds, marshes			Feeds both in and out of the water		To deeper ponds		
MASSA-SAUGA RATTLE-SNAKE	Diurnal		Nocturnal-Crepuscular			Diurnal		
	Breeding at 2-3 years of age		Sunny openings and shady woodland or shrub areas for basking, foraging		Live young born		Moves up to 1.2 mi. to hibernate. Crayfish burrows, tree roots near water table	
	may be over 1/3 mi from wetlands Food: mice, shrews, voles, frogs							
WESTERN SLENDER GLASS LIZARD		Mating	Nesting	Incubate			Hibernation in old mammal burrows below frostline	
	at 2-3 yrs. of age			Hatch				

	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	WINTER
	caterpillars, beetles, spiders		Foraging underground and above for katydids, crickets, grasshoppers					

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B. "Karner Blue Management Implications for Some Associated Lepidoptera of Wisconsin Barrens" by R.J. Borth with contributions from G.J. Balogh, T.S. Barina, L.A. Ferge, H.L. Kons, Jr., M.C. Nielson, J.C. Parkinson and A.B. Swengel.

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Introduction

Barrens ecosystems were once dependent on natural disturbance to maintain a diverse community of flora and fauna, but are becoming increasingly dependent on informed management to preserve early successional stages. In 1992 the Karner blue butterfly, which is largely associated with barrens habitat, was listed as a federally endangered species by the U. S. Fish and Wildlife Service (USFWS, 1992). After conducting surveys to better understand this species and its remaining stronghold in Wisconsin barrens, a partnership between the Wisconsin Department of Natural Resources and various public and private interests was formed to develop a habitat conservation plan (HCP) pursuant to Section 10 of the Federal Endangered Species Act. Partnership goals were expanded to encourage consideration for other barrens associated species that co-occur with the Karner blue and could therefore be impacted by Karner blue management. This report is designed as a reference summarizing current information on the basic biology of ten other species with varying degrees of association with the barrens community in Wisconsin for those interested in protecting other lepidoptera when managing for the Karner blue.

The Wisconsin barrens are associated with sandy soils and consist of a continuum of communities stretching across the state from southwestern treeless sand barrens and central oak barrens to northwestern jack pine and burr oak barrens. Wild lupine (*Lupinus perennis),* the Karner blue's exclusive hostplant, achieves its maximum presence in the oak barrens (Curtis, 1959). The Karner blue's dependence on ephemeral lupine populations, which are subject to succession and have historically been dependent on wildfires to open new sites of invasion, implies a dynamic mosaic of Karner blue populations with some going extinct as others colonize new sites (Givnish, Menges and Schweitzer, 1988).

The ten species covered in this report were initially treated by Kathryn Kirk in a November, 1996 report to the U.S. Fish and Wildlife Service entitled "The Karner Blue Community: Understanding and Protecting Associated Rare Species of the Barrens." Reviews which questioned certain information in that report, including comments based on broad geographical generalizations not always applicable to Wisconsin, were the catalyst for this report, which substantiates summarized charts for these same 10 species with detailed field observations primarily by Wisconsin lepidopterists and photos in natural habitat by the author.
Each of these 10 species has some association with barrens and is classified as either endangered, threatened or "of special concern" in Wisconsin. Because there are varying degrees of overlap between habitat occupied by Karner blues and these other species there was no consensus among the contributors on which species to include (aside from the Frosted elfin and Persius dusky wing which are host specific on lupine). The fact that only one moth species is included is indicative that current knowledge of moths and their habitat associations is even more limited than for butterflies.

Certain Karner blue sites may not contain any of these other species, while other barrens habitats may include various combinations of species and no lupine or Karner blues. The HCP can benefit

associated species where they co-occur with the Karner blue, but it must not be viewed as an overall strategy to preserve the entire barrens ecosystem in Wisconsin or these associated lepidoptera and other insects. This would require an ecosystem based approach including many sites where the Karner blue is absent. Despite many unknowns about barrens species and their habitat preferences, conservation strategies and management must cautiously proceed.

Species Accounts

The following species accounts are based on current but incomplete information as these species (especially their immature stages) have not been given the same attention as the Karner blue. When Wisconsin information is unavailable, other sources are cited, but these should be used carefully as there may not be consistency between geographic regions. Species identifications were the responsibility of the individual contributors.

Range Maps: The range maps provide each associated species' documented range in Wisconsin based on voucher specimens or photos from the following sources: George Balogh, Thomas Barina, Susan Borkin, Robert Borth, Leslie Ferge, Hugo Kons Jr., Judy Maxwell, James Parkinson, Thomas Rocheleau, Ann Swengel, the Milwaukee Public Museum (identifications checked by R. Borth) and published accounts by Kuehn (1983). The Karner blue data was obtained from the HCP. Figures of each species (actual size) are also shown. It is anticipated that further survey work will yield additional county records.

Life History: The "Life History" summary provides information on the life stages of each species including the Karner blue. Because little basic life history research on the immature stages is available for these species in Wisconsin, this chart and additional comments on the egg, larvae and pupae rely largely on published studies from outside the state. The life cycle may vary between seasons due to differences in weather and other factors as well as between different parts of the state.

Known Larval and Adult Resources: Typical adult nectar sources, which are based primarily on the observations of Wisconsin lepidopterists contributing to this report, and larval host plants are listed. Frequent Karner blue nectar resources are also provided from Bleser (1994).

Status: Status refers to current perceptions, which may be biased by inadequate survey, of how local/restricted in habitat and how numerous a species may be where present in Wisconsin. Ambiguous or inconsistently used terms such as "rare" are deliberately avoided. There is an enormous amount of interesting habitat in Wisconsin that has never benefited from the attention of a lepidopterist. Time and again various species are proclaimed "rare" when as Ferge (1997) notes "what is rare is the intense and time consuming effort to locate and document new populations in the field."

Similar Species: This section highlights other species, using scientific names, that make identifications difficult due to similar appearance and overlapping flight season. Separation from similar species is best learned by studying either an institutional or personal reference collection with large series of similar species where inter and intraspecific variability (e.g. genetics/environment, sex, season, geography, age, etc.) can be studied in detail. In addition, Scott (1986) has color plates, illustrating upper and underwing surfaces, and descriptions of each of the 9 butterfly species covered here. Voucher specimens or photos showing diagnostic features should be obtained to validate reported occurrences.

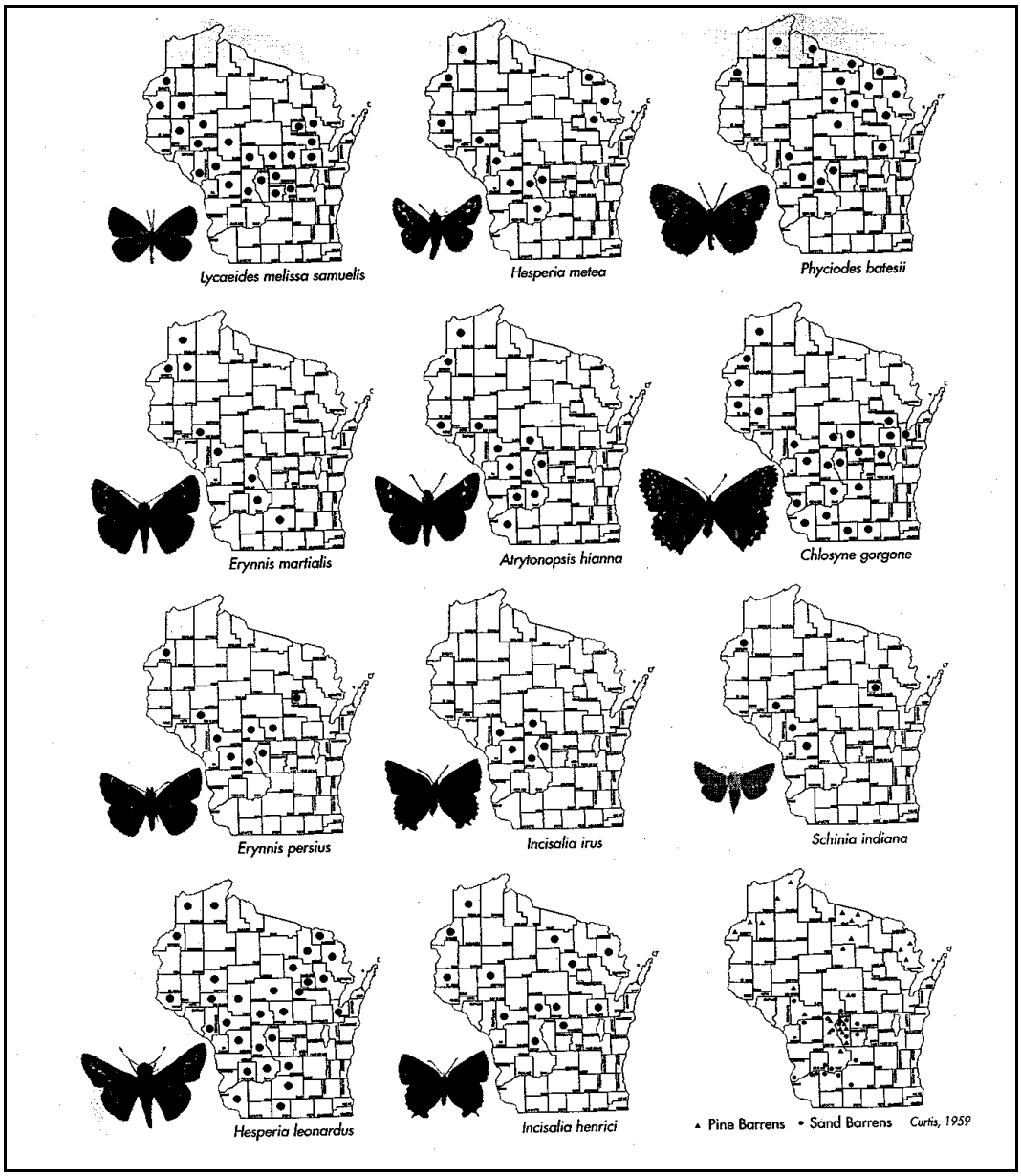
Habitat: This section discusses types of habitat where the associated species have been documented in Wisconsin. While the habitat requirements of each species actually include the habitat needs of both adult and immature stages, most observations are based only on the adults. Knowing these habitat preferences might help predict the possible occurrence of these species in a given site (which should be established by actual survey) and may be useful in designing an appropriate management strategy.

Behavior: This section covers observed behavior, limited to that of adults, with emphasis on Wisconsin.

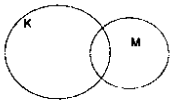
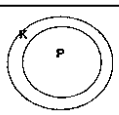
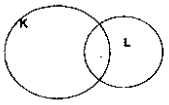
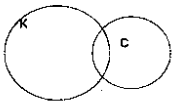
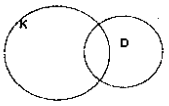
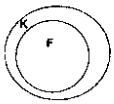
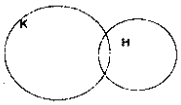
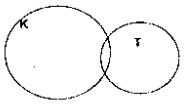
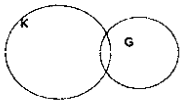
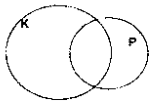
Dispersal: Dispersal may be motivated by individuals seeking food, mates, or egg laying sites or in some cases it may be migratory (Lane, 1997). For the dynamic landscape model (Givnish et al, 1988) (local extinctions and recolonizations as areas open due to disturbance) to apply, species must display sufficient dispersal ability. This section summarizes dispersal ability inferred by indirect evidence such as records far from known locations of larval hosts or records in areas where a species is not found persistently despite intensive survey. Studies dedicated to dispersal such as King's (1996) Karner blue study have not been done on these species.

Management: This section summarizes the limited information available on management, using Wisconsin data when possible. Caution must be applied when using information from another region. Ideally management should strive to maintain the habitat required for each life stage without causing adverse impacts to populations of other barrens associated species.

Range Maps


Lycaeides melissa samuelis
Hesperia metea
Phyciodes batesii
Erynnis martialis
Atrytonopsis hianna
Chlosyne gorgone
Erynnis persius
Incisalia irus
Schinia indiana
Hesperia leonardus
Incisalia henrici
▲ Pine Barrens • Sand Barrens Curtis, 1959

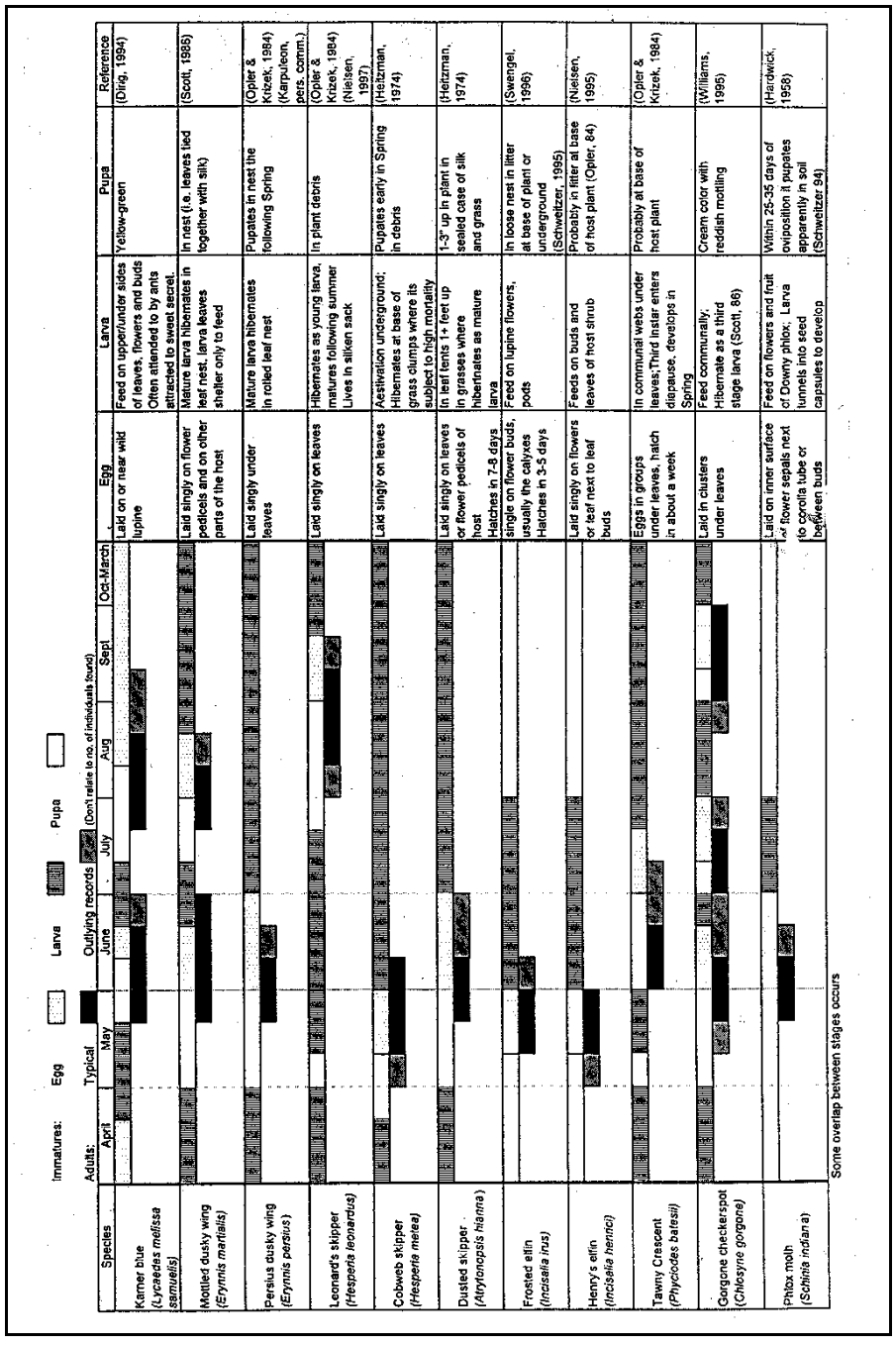
Relationships and Strategies

	Rough Estimate of Co -occurrence with Karner blue (1)	Preferred Habitat within Barrens Community	Management Strategies (2) (Vary depending on Site)	
			Recommended	Discouraged
Mottled dusky wing *Erynnis martialis*		Ceanothus area: patches of bare ground narrow oak branches for perching	Mowing sections of habitat during dormant season if Ceanothus is present	Spring, summer burns Extensive burns
Persius dusky wing *Erynnis persius*		Lupine area: patches of bare ground narrow oak branches for perching	Late season mowing or moderate methods to maintain openings	Intensive clearing of woody species
Leonard's skipper *Hesperia leonardus*		Open to scrub forest: purple flowers for nectar esp. liatris	Maintenance of openings	Burning more than a small part of breeding habitat
Cobweb skipper *Hesperia metea*		Grassy opening: bluestem grasses for perching birdfoot violet available for nectar	Cool, fast moving, patchy fires	Intensive fire rotation Burning more than a small part of breeding habitat
Dusted skipper *Atrytonopsis hianna*		Sandy grassland: bluestem grass present puccoon available for nectar	To date no active management strategy has been found to be of benefit	Mowing and intense fire
Frosted elfin *Incisalia irus*		Dense lupine area: some shading from canopy (savannah aspect)	Unintensive late season mowing and timber cutting	Virtually any fire management regime
Henry's Elfin *Incisalia henrici*		Scrub pine/oak barrens mosaic: some ground cover of heaths Woodland edges	Unintensive cutting	Over-clearing or thinning of woody species Frequent burning
Tawny crescent *Phyciodes batesii*		Various dry forest edges or barrens /scrub forest	Unknown	Unknown
Gorgone checkerspot *Chlosyne gorgone*		Dry open areas: Yellow flowers for nectar Prairie/barrens composites for larval hosts	Unknown	Extensive burning, mowing and cutting
Phlox moth *Schinia indiana*		Dense downy phlox area	Maintenance of openings and edges	Intensive burning

(1) Degree of overlap provides information on how highly the species on the left (indicated by first initial of common name) is associated with the Karner blue (K). For example, *E. persius* and *I. irus* are highly associated with Karner habitat while *P. batesii, C. gorgone, I henrici*, and *H. leonardus* are significantly less associated with the Karner blue. See species accounts.

(2) Recommendations are in need of further research. If no management strategy is clearly beneficial it may be prudent to leave significant portions of occupied habitat unmanaged until more is known.

Life History



Species	Egg	Larva	Pupa	Reference
Karner blue (*Lycaeides melissa samuelis*)	Laid on or near wild lupine	Feed on upper/under sides of leaves, flowers and buds Often attended to by ants attracted to sweet secret.	Yellow-green	(Dirig, 1994)
Mottled dusky wing (*Erynnis martialis*)	Laid singly on flower pedicels and on other parts of the host	Mature larva hibernates in leaf nest. larva leaves shelter only to feed	In nest (i.e. leaves tied together with silk)	(Scott, 1986)
Persius dusky wing (*Erynnis persius*)	Laid singly under leaves	Mature larva hibernates in rolled leaf nest	Pupates in nest the following Spring	(Opler & Krizek, 1984) (Karpuleon, pers. comm.)
Leonard's skipper (*Hesperia leonardus*)	Laid singly on leaves	Hibernates as young larva, matures following summer Lives in silken sack	In plant debris	(Opler & Krizek, 1984) (Nielsen, 1997)
Cobweb skipper (*Hesperia metea*)	Laid singly on leaves	Aestivation underground; Hibernates at base of grass clumps where its subject to high mortality	Pupates early in Spring in debris	(Heitzman, 1974)
Dusted skipper (*Atrytonopsis hianna*)	Laid singly on leaves or flower pedicels of host Hatches in 7-8 days	In leaf tents 1+ feet up in grasses where hibertnates as mature larva	1-3" up in plant in sealed case of silk and grass	(Heitzman, 1974)
Frosted elfin (*Incisalia irus*)	single on flower buds, usually the calyxes Hatches in 3-5 days	Feed on lupine flowers, pods	In loose nest in litter at base of plant or underground (Schweitzer, 1995)	(Swengel, 1996)
Henry's elfin (*Incisalia henrici*)	Laid singly on flowers or leaf next to leaf buds	Feeds on buds and leaves of host shrub	Probably in litter at base of host plant (Opler, 84)	(Nielsen, 1995)
Tawny Crescent (*Phyciodes batesii*)	Eggs in groups under leaves, hatch in about a week	In communal webs under leaves;Third instar enters diapause, develops in Spring	Probably at base of host plant	(Opler & Krizek, 1984)
Gorgone checkerspot (*Chlosyne gorgone*)	Laid in clusters under leaves	Feed communally; Hibernate as a third stage larva (Scott, 86)	Cream color with reddish mottling	(Williams, 1995)
Phlox moth (*Schinia indiana*)	Laid on inner surface of flower sepals next to corolla tube or between buds	Feed on flowers and fruit of Downy phlox; Larva tunnels into seed capsules to develop	Within 25-35 days of oviposition it pupates apparently in soil (Schweitzer 94)	(Hardwick, 1958)

Suspected Larval and Known Adult Resources in Wisconsin

Suspected Larval & Known Adult Resources in Wisconsin

	L. melissa	*E. martialis* *	*E. persius*	*H. leonardus* *	*H. metea* *	*A. hianna* *	*I. irus*	*I. henrici* *	*P. batesii* *	*C. gorgone*	*S. indiana* *
Larval Host											
Asters - *Aster sp.*									X		
Coneflower - *Ratibida pinnata*										X	
Big bluestem *Andropogon gerardi*				X	X	X					
Black-eyed susan -*Rudbeckia hirta*										X	
Blueberry- *Vaccinium sp.*								X			
Downy phlox-*Phlox pilosa*											X
Jersey tea-Ceanothus americanus/C. ovatus		X									
Little bluestem - *Schizachyrium scoparius*				X	X	X					
Maple-leaf viburnum - *Vibernum acerifolium*								X			
Sunflower- *Helianthus*										X	
Wild lupine - *Lupinus perennis*	X		X				X				
Adult Nectar Source											
Asters - *Aster sp.*	X	X		X							
Birdsfoot violet - *Viola pedata*					X						
Black-eyed susan -*Rudbeckia hirta*	X									X	
Blazing star - *Liatris sp.*	X	X		X							
Bush hustonia - *Hustonia sp.*		X									
Butterfly milkweed - *Asicepias tuberosa*	X									X	
Choke cherry - *Prunus virginiana*								X			
Cinquefoil - *Potentilla sp.*	X									X	
Dewberry- *Rubus flagellaris*	X					X					
Downy phlox-*Phlox pilosa*		X				X					X
Flowering spurge- *Euphorbia corollata*	X										
Goldenrod -*Solidago sp.*	X										
Heaths - Fam. ericaceae		X						X			
Hoary allysum - *Berteroa incana*	X										
Horsemint-*Monarda punctata*	X										
Knapweed - *Centaurea bieberstinii*	X										
Leadplant - *Amorpha canescens*	X										
Orange hawkeed- *Hieracium aurantiacum*	X		X						X	X	
Puccoon - *Lithospermum sp.*						X				X	
Rock cress - *Arabus lyrata*	X	X	X		X			X		X	
Sunflower- *Helianthus*	X			X						X	
White sweet clover - *Meliotus alba*	X										
Wild bergomont - *Monarda fistulosa*	X			X							
Wild lupine - *Lupinus perennis*	X		X			X	X				
Wild strawberry - *Fragaria virginiana*					X	X					
Other											
mudpuddles	X		X	X			X		X	X	
Urine, salts		X						X	X	X	
Dung	X								X		

* Larval host data from out-of-state records

Mottled Dusky Wing *Erynnis martialis* Scudder

Hesperiidae Pyrginae

Status - This species is local and dependent on extensive barrens habitats in central Wisconsin as well as in the northwestern counties where it may be numerous.

Similar Species - Several other *Erynnis* species can be heavily mottled, making *E. martialis* especially prone to misidentification. Summer brood individuals are easier to identify, as not all *Erynnis* species have second broods.

Habitat - Many adults were seen in a scrub forest/barrens mosaic and adjacent open sandy fire lane by Kons and Borth in the vicinity of the Namekagon barrens, Burnett County, but observations decreased markedly out into the contiguous open, frequently burned (every 4-6 years), treeless barrens (1997). Ferge (1989) reported the species as absent in these burn units.
Behavior - These behavioral observations were made by Kons and Borth in the vicinity of the Namekagon barrens (1997). In both the scrub forest/barrens mosaic and in the open, adults usually fly close to the ground and bask in sunlight with wings outstretched and forewing tips curved slightly inward. Numbers found peaked during intense sunny conditions when individuals were observed patrolling or visiting moist sand to imbibe fluids, rich in salts. Under cloudier conditions, *E. martialis* was generally not found on the open sandy fire lane but would be in the scrub forest barrens mosaic habitat perching up to several feet above the ground on burr oaks and small shrubs. During sunny intervals, some individuals would pursue approaching *Erynnis* or *Incisalia.*

Dispersal - Although dispersal is unknown, this species is a strong flier typical of *Erynnis***.**

Management - While a suspected host plant redroot is able to withstand fire (due to the huge underground burl-like root stock) (Curtis, 1959), the larval leaf nest and pupae are above ground rendering the species vulnerable to spring burns. In the East, Schweitzer suggests mowing sections of habitat during the dormant season if *Ceanothus* is present (1994) to protect second brood larvae. Kons and Borth (1997) recommend that in the vicinity of Namekagon barrens maintenance of preferred habitat includes both the scrub forest/barrens mosaic with small oaks and open sandy areas in addition to *Ceanothus americanus.*

Persius Dusky Wing *Erynnis persius* Scudder

Hesperiidae Pyrginae

Status - This species is found in some numbers in a subset of Karner blue sites but it is not as numerous as the Karner blue. Many Karner blue sites have not yet been surveyed for *E. persius*.

Similar Species - *Erynnis persius* is very difficult to distinguish from *E. lucilius* (whose foodplant, Columbine, is found in dry sites throughout central Wisconsin) and *E. baptisiae* (which can also use lupine as a larval host (Schweitzer, 1994)). It may also be mistaken on the wing for the more abundant dusky wings with which it flies. Because this species cannot be reliably separated in the field or by photograph (Schweitzer, 1994a, Nielsen, 1997) it should be documented with voucher specimens.

Habitat - This species is found primarily in openings or perching on sparsely vegetated sandy ground. At the Emmons Creek Public Hunting Area in Portage County (Kons,1997) *E. persius* adults were found principally in areas with sparser vegetation where open sandy and dormant grass covered ground was interspersed with immature scrub oaks while Karner blue adults were numerous wherever lupine was present at the site (including densely grassy areas). *E. persius* was absent at two sites in Portage County where Karner blues were numerous and these sites lacked the combination of open sparsely vegetated ground and small oaks (Kons, 1997). Maxwell and Ferge report the species in both open and shady oak woodland habitat at Fort McCoy in Monroe County (1994).

Behavior - *E. persius* may pause from its generally quick and erratic flight to bask in sandy sparsely vegetated areas or to nectar on low growing blueberry (pers. obsv., 1997). At Emmons Creek under cloudy conditions Kons observed *E. persius* and *E. brizo* landing on small diameter scrub oak branches and exhibiting "cryptic perching behavior" where they would wrap their wings around a branch covering from half to the entire circumference of the branch with their wings and become very difficult to detect except at very short range. "Cryptic sleeping posture" of *E. brizo* was previously reported by Burns (1969). Kons has found that this species, like the Karner blue, flies through areas of closed forest (1997). In Ohio, *E. persius* will not oviposit on shaded plants (Iftner et al., 1992).

Dispersal - Dispersal is apparently high as two specimens were found by Borth and Kons in Burnett county at least five miles from known lupine plants (Kons and Borth, 1997). At Emmons Creek, Kons inferred that this species dispersed through closed forest based on finding small numbers of *E. persius* in a barrens opening surrounded by forest which contained only 1 lupine plant (1994 and 1995). Kons also found one individual along a road about one mile from the lupine area.

Management - Management that may be beneficial for Karner blues, which may be numerous in sites where this species is absent, may not benefit *E. persius* unless the above habitat

requirements are maintained. Shrubs causing excessive shade should be removed and Schweitzer recommends mowing during the fall - no earlier than mid-July (1986). While it was found in recently burned areas at Fort McCoy (Maxwell and Ferge, 1994), until more is known fire should be used sparingly in sites occupied by *E. persius*. Apparently no prior burning or active management was being conducted at Emmons Creek barrens where Kons found many *E. persius* during 1993 and 1994.

Leonard's Skipper *Hesperia leonardus* Harris

Hesperiidae Hesperiinae

Status - Of the three bluestem-feeding skippers covered in this report *H. leonardus* is the most widespread and abundant (Parkinson, 1997). It can be locally common in prairie and barrens habitats and can also be found in more degraded sites.

Similar Species - *H. leonardus* also closely resembles *H. comma laurentina* which also flies in barrens, generally north of Karner blue range. *H. leonardus* is also somewhat similar in size and coloration to some other skippers.

Habitat - Although it is frequently found in barrens, associated with stands of bluestem grasses, *H. leonardus* appears to be more tolerant of habitat degradation than *H. metea* (Swengel, 1994b). Males may be found at roadside puddles and patrolling near concentrations of *Liatris aspera* (Maxwell and Ferge, 1994, Parkinson, 1997). This species comes to moisture in numbers along dirt roads through moist forest habitat in northeastern Wisconsin (Kons, 1997, Parkinson, 1997). Nielsen has found *H. leonardus* nectaring in moist meadows and old fields in Michigan (1997).

Behavior - Kons has observed this species primarily on purple flowers, including liatris and asters (Kons, 1996). Nielsen recorded a Michigan observation of a *H. leonardus* being seized by a robber fly (Asilidae) species, *Proctacanthus milberti,* as it flew from feeding on a liatrus flower (1977). This skipper is a strong flier and is often quite wary (pers. obsv.). Nielsen has observed it ovipositing on *Danthonia spicata* in pine barrens in Otsego County, Michigan (1997).

Dispersal - *H. leonardus'* dispersal ability may be substantial. Its appearance in numbers on a dirt road through a moist forest in Marinette County and along the grassy shoreline of a manmade lake at Lake DuBay Park in Portage County may provide evidence either that this species may be dispersing from its breeding habitat or that some populations are not dependent on barrens or prairie habitat (Kons, 1997).

Management - *H. leonardus* showed a very negative effect from fire which may persist for 3-5+ years (Swengel, 1995). Schweitzer also feels it is quite vulnerable to fire, though cool, fast moving fires are likely less lethal (1985).

Comments - Individuals found in the Wisconsin Karner blue range belong to the subspecies of *Hesperia leonardus leonardus.*

Cobweb Skipper *Hesperia metea* Scudder

Hesperiidae Hesperiinae

Status - While this species is of localized occurrence it can be found in considerable numbers over extensive barrens in northern Wisconsin.

Similar Species - Its early flight distinguishes it from many other skippers, but the flight overlaps with *Amblyscirtes vialis* and *A. hegon,* the latter of which is similar in size and coloration to female *H. metea*.

Habitat - *H. metea* occurs only where bluestem grasses (*Andropogon* spp.), the larval food plants, are a consistently dominant element of the herbaceous vegetation. Possible sites may be recognized in the fall by the red-brown cast of bluegrass stems forming a dense cover (Shapiro, 1965). It generally flies in dry, open, sterile bleached out grassy areas, but may also be found in areas with some scattered trees (Borth, Kons, Barina pers. obsv.). Within the barrens habitat in Wisconsin, locations with abundant Karner blue butterflies were not found favorable for *H. metea* by Swengel (1994b). Ferge has found the species at Namekagon Barrens in openings of jack pine-oak scrub, and along the fire breaks at the edges of areas managed with fire where nectar sources were most abundant (1989).

Behavior - As described in (Kons, 1995), Borth and Kons observed males frequently perching near the tips of dead grass blades in grassy open areas. The skippers were very wary and difficult to approach and would frequently fly up in pursuit of other males patrolling over the grass level. These chases would occur at an accelerated rapid flight, rising up high over the barrens. Because *H. metea* is small and often flies low to the ground in the grass litter, it is difficult to follow in flight. Females flew slower and low to the ground where they would occaisionally nectar on birdfoot violet. In Jackson County in shorter grass habitat both males and females flew low to the ground and nectared on birdfoot violet (pers. obsv.).

Shapiro feels that a definite transient territoriality exists where males feed in early morning and then extend their range in late morning, each occupying a specific site and normally returning to it when disturbed (1965). Shapiro observed both sexes flying into the shade for

short periods only (1965). Kons found only females on dates ranging from 3 to 10 June during 1993 and 1995 in Marinette County, but earlier in the season on 21 May, 1994 males outnumbered females there (1997).

Dispersal - Dispersal is unknown but this species is a strong and rapid flier.

Management - *H. metea* requires enough management so that little bluestem, which is an early successional species, is not shaded out by woody growth. Although it is not known how deep larvae tunnel underground, in the East Schweitzer has found survival of *H. metea* to be good after cool, fast-moving fires (1985). Shapiro found the skippers in burned-over sites the second year following wildfire which had allowed the bluestem grasses to become dominant (1965) but notes its disappearance once the grass is shaded out by trees or is replaced by other grasses. Swengel found wildfires more favorable than prescribed burning (1997a).

Dusted Skipper *Atrytonopsis hianna* Scudder

Hesperiidae Hesperiinae

Status - This species can be found in numbers, locally, in sandy barrens areas in western Wisconsin. The species appears to be absent from the eastern portion of the Karner blue range in Wisconsin.

Similar Species - Its early flight is helpful for identification but it may be mistaken for other larger dark skippers such as *Thorybes* species.

Habitat - *A. hianna* has been found on dry open sand barrens with sand blowouts as well as open savanna areas and edges (pers. obsv.). Parkinson has seen this species in Wisconsin only where puccoon and phlox are found (1997). The Swengels found no abundance correlation with the Karner blue (Swengel and Swengel, 1997).

Behavior - In sunny weather Shapiro found it to be a much more active and aggressive species than *H. metea* (1965). He found that feeding occurs in early morning and late afternoon and that females fly low, generally 6-8 inches above the ground. Balogh has observed it in Eau Claire County nectaring on the same roadside patch of phlox where a pair of *S. indiana* was found (1987).

Dispersal - Dispersal is unknown in Wisconsin but Shapiro observed in the East that *A. hianna* "wanders a good deal more than *H. metea*" (1965).

Management - Pupation is up to three inches above the ground and larvae are found up to several feet above the ground (Heitzman, 1974) which probably explains its aversion to mowing and unintensive cutting (Swengel, 1997). Because succession is slower on hot sandy soils it may be that infrequent limited management is best here.

Comment - Females emerge six days after the males and Shapiro believes the following ten days to be the optimum survey period in Pennsylvania (1965).

Frosted Elfin *Incisalia irus* (Godart)

Lycaenidae Theclinae

Status - Swengel has published a detailed account of *I. irus* (1996), which is the basis of much of this discussion and confirms its relatively low numbers (less than a 1:20 ratio compared to Karner Blues) even in its specialized habitats (Swengel and Swengel, 1997). It is clearly the least numerous of Wisconsin's lupine feeding butterflies where it inhabits a small subset of Karner blue sites. While all of Swengel's *I. irus* sites also supported Karner blues, her findings also suggest a fair degree of niche segregation, as discussed in Shapiro (1974).

Similar Species - It is one of 5 elfins recorded from Wisconsin all of which fly in the spring and may occur in barrens. It is most likely to be confused with *I. henrici* or *I. polios*.

Habitat -Frosted elfins are rarely found in expanses of lupines blooming profusely in wide open, sunny places, but instead are found in somewhat shadier places with enough sun for lupines to flower and enough shade to prolong flowering. Swengel hypothesizes that greater local canopy diversity and higher canopy density (until lupine flowering drops markedly) would be favorable to prolong the flowering season, all the better to ensure adequate food throughout larval development (1996b). Some canopy may also be beneficial during drought periods. Typically a large patch or series of smaller patches of high-density lupine was required. Swengel (1994b) and Parkinson (1997), respectively, have found the species in patches of high-density lupine in woods openings and within 10 feet of canopy cover in a more open landscape.

Behavior - The primary flight is just prior to peak lupine bloom (Swengel, 1996b). Adults exhibit a characteristic low flight with frequent perching on or near clumps of lupine in scattered oak openings (Balogh, pers. comm. 1996). Swengel found that individuals sometimes perched and flew in the shade, but they usually occurred in sunny patches (if the sun was shining) even in areas of high-density canopy (1996). Paired spiral intraspecific flights emanated vertically, sometimes well out of sight (Swengel, 1996b). Some exhibited heat minimizing perching behaviors (angling to reduce its shadow, perching within shaded vegetation) at temperatures over 27 degrees C. (Swengel, 1996b). Balogh observed perching to maximize sun exposure (angled wings sideways) on cool sunny days in Michigan (1997).

Dispersal - Swengel found most on lupine with nearly all within .5 m of lupine. Schweitzer (1994a) has found adults in the East on new lupine growth within 2 weeks of a burn.

Management - Management that is beneficial to Karner blues may be unsuitable for *I. irus*. For *I. irus* it is critically important to maintain not only abundant lupine but also dappled or partial sun (Swengel, 1996c). Unintensive late season mowing and timber-cutting are potentially valuable strategies. Areas managed with late-season mowing and with only part of the habitat cut

each year appear to benefit the species according to Swengel's observations at several rights-of-way sites in Wisconsin (1994). Her best and most consistent *I. irus* site was managed with late-season mowing no more frequent than one cut/year, with only a partial cutting of the habitat in many years (1996b).

Fire management of entire sites is extraordinarily averse for *I. irus*, is at least as harmful as no management at all, and should be distinguished from wildfire effects on *I. irus* populations (Swengel, 1996b). Significantly more butterflies have been found in areas burned by wildfire over five years previously (Swengel, 1996b). Wildfire areas are surrounded by habitat that have been left unburned for much longer than are fire-managed areas where the entire habitat is burned by units on a rotational basis. May fires could be particularly detrimental by altering lupine phenology and flower abundance as well as direct egg mortality (Swengel, 1994). Numbers significantly increased with less frequent fire and with non-fire managements, especially mowing (Swengel and Swengel, 1997).

Henry's Elfin *Incisalia henrici* (Grote and Robinson)

Lycaenidae Theclinae

Status - This species has generally been found locally in northwestern Wisconsin north of Karner blue habitat, where it may be numerous in oak-pine scrub forest/barrens mosaic. It has been found infrequently in the central or northeastern parts of the state.

Similar Species - It can be confused with more numerous *Incisalia polios, I niphon* and *I. augustinus* with which it often flies. It is similar to *I. irus* (above), especially if worn, and to a lesser extent *I. augustinus*.

Habitat - *I. henrici* has been found in considerable numbers in the extensive heath-covered oak and jack pine forest/barrens mosaic habitat that occurs to the north of the Namekagon barrens in Burnett County (Kons and Borth, 1997). Two concentrations were noted here within the scrub forest/barrens mosaic (Kons and Borth, 1997), however some individuals were found throughout the mosaic. Individuals were rarely found on an adjacent open fire lane, and never on the open frequently burned barrens. Only one individual was found by Borth and Kons over 2 years at the Dunbar barrens, which lack scrub forest /barrens mosaic and contain primarily open barrens and closed forest (Kons, 1997). In addition to openings in oak-heath scrub barrens, individuals have been recorded in bogs in northern Wisconsin (Ferge, 1997) and moist forest in Outagamie and Portage Counties (Kons, 1997).

Dispersal - Some evidence of its potential dispersal ability is suggested by only single individuals being found by Kons in an Outagamie County swamp forest and by James Kruse in swamp forest at Schmeeckle Reserve in Portage County despite intensive searching during subsequent seasons (Kons, 1997).

Behavior - Its spiraling flight can be rapid and erratic, but it may be approachable when flying slow and close to the ground (Kons and Borth, 1997). Repeated perching behavior towards the ends of bur oak or shrub branches occurs generally below six feet in height (Kons and Borth, 1997). Nielsen has observed *I. henrici* (before full leaf development along Michigan's sandy trails and narrow wooded sunny openings) as they perched on small shrubs, on dried leaves and twigs or on bare sand (1985). Pairs may spiral together at some height and one individual was even seen to land roughly 15 feet up in a jack pine (Kons and Borth, 1997). *I. henrici* may rub its hindwings together (Iftner, 1992), which is characteristically done by members of the hairstreak group (Scott, 1986) to simulate the head and antennae, to draw the attention of predators to the wings instead of the head (false head hypothesis).

Management - The association of the adults with small trees or shrubs as observed in the vicinity of the Namekagon barrens argues against excessive clearing of woody species or frequent burning in occupied habitat (Kons and Borth, 1997). Some thinning may be necessary as no individuals were found in nearby areas allowed to succeed to dense canopy (Kons and Borth, 1997). *Viburnum*, which has been identified as a larval host shrub in Michigan, is found in wooded edges (Balogh, 1997).

Tawny Crescent *Phyciodes batesii* Reakirt

Nymphalidae Nymphalinae

Status - Many contributors questioned this species' inclusion in the report due to its very minimal association with the Karner blue and secure and widespread status especially in the northern part of the state beyond lupine's range. It may be numerous in extensive areas of similar habitat.

Similar Species - This species is very similar in appearance to *P. pascoensis* and *P. tharos* (the latter is infrequent to absent in northern Wisconsin) so voucher specimens are needed. Males are more readily identified than females.

Habitat - In the vicinity of the Namekagon barrens, it was numerous in more open barrens/scrub forest habitat and along an open sandy fire lane at the edge of this habitat (Kons and Borth, 1997). In some barrens areas, including extensive sites in northeast Wisconsin, it is numerous at the edge of dry forests which may maintain some degree of barrens character (Kons and Borth, 1997). In Marinette County the species is much more common in the dry forest edges than on nearby open barrens (Kons, 1997).

Behavior - Its flight is generally low to the ground, and not rapid unless disturbed (Kons and Borth, 1997). Males in particular congregate over sandy roads where they feed on dung and urine

(Kons, pers. comm.).

Dispersal - It is difficult to determine the degree of dispersal as the species is often widespread and difficult to distinguish from other species. Adults may disperse out of their breeding habitat for moisture and nectar (Ferge, 1997).

Management - Although no information on management was found it would be useful to maintain areas of asters, potential larval hosts, along forest edges and in the barrens.

Comments - The author feels it would be unwise to list this species as federally threatened or endangered due to its widespread occurrence in Wisconsin and great similarity to other species.

Gorgone Checkerspot *Chlosyne gorgone* Hubner

Nymphalidae Nymphalinae

Status - This species is apparently more associated with barrens and prairies in Wisconsin than throughout the Great Plains where it is found in a variety of habitats. It can be found in numbers, locally.

Similar Species - The underside hindwing pattern is distinctive**.**

Habitat - In Wisconsin, lepidopterists noted that the species inhabits both barrens and dry prairies (Ferge, 1990). It may be numerous along roadsides or agricultural areas in southwestern Wisconsin in certain years (pers. obsv.) or colonize prairie plantings (Kons, 1997). The Swengels found no correlation between Karner blue and *C. gorgone* abundance (Swengel and Swengel, 1997).

Behavior - Swengel (1995) has found this species nectaring primarily on orange-yellow flowers (31 out of 40 nectar records). This species usually flies low to the ground and in taller prairies flies just over the vegetation (Kons, pers. comm.).

Dispersal - Kons has inferred evidence of substantial dispersal ability due to *C. gorgones'* appearance at two sites in Outagamie County where intensive survey failed to uncover it during prior seasons. One of these sites was a butterfly garden owned by Richard Merkhofer who reared *C. gorgone* larvae found there on Gloriosa Daisies (1997). In addition this species apparently colonized a prairie planting (planted from seed) at Mosquito Hill Nature Center in Outagamie County (Kons, 1997).

Management - Kons (1997) observed that a *C. gorgone* colony in Outagamie County was apparently eradicated after an entire prairie planting was burned during Spring, 1991, providing

circumstantial evidence that it is highly sensitive to burns. It had been numerous there the previous 2 years and recolonization had not taken place as of 1995. This species is also averse to mowing and unintensive cutting (Swengel, 1997).

Comments - Kons (1997) and Swengel (1994) have detected a third or partial third brood in Wisconsin during some years.

Phlox Moth *Schinia indiana* Smith

Noctuidae Heliothinae

Status - This species is listed by the Wisconsin Department of Natural Resources as "endangered" in Wisconsin. This species was first discovered in Wisconsin in an Eau Claire County power line cut in June 1973 by Fay Karpuleon. A total of 49 individuals were uncovered in Menominee county at 11 sites in the vicinity of Legend Lake over three days of intensive searching by Kons and Borth (1992). *S. indiana* was associated with *P. pilosa* occurring in extensive sandy oak/pines habitat along roadsides and trails. It was then found at 34 sites in oak savannah at Fort McCoy from 1993-1996 (Maxwell and Ferge, 1994; Kirk, 1994; Kirk, 1995). Two Burnett County sites and over 5 Jackson County sites have been found by Swengel (1994). Sparce county records may be indicative of the fact that this species cannot be found by customary collecting techniques.

Similar Species - In contrast to many Noctuidae this is a colorful, diurnal species readily identifiable in Wisconsin.

Habitat - The habitat is pine-oak barrens on sandy soils where *P. pilosa* is found (Balogh, 1987) (Kons and Borth, 1992). In Menomonee County it was found in both sparsely and thickly vegetated phlox areas (Kons and Borth, 1992). It is also found on open prairies in western Minnesota (Balogh, 1997).

Behavior - This species is well camouflaged on Downy phlox blossoms on which it rests, making it difficult to spot. Searches for the moth were not as productive under hot sunny conditions during which some individuals were seen to exhibit a rapid, darting flight (Kons and Borth, 1992). Kons and Borth found moths in both sunny and shaded areas (1992).

Dispersal - It has short range dispersal into and out of patches of phlox (Kons and Borth, 1992), however longer range dispersal is unknown.

Management - Review of the species' life cycle indicates that removal of above-ground phlox growth from May to July would be harmful. Several *S. indiana* locations in Wisconsin are rights-of way where roadside mowing may be safely undertaken in August when presumably the species is underground (Maxwell and Ferge, 1994). Depth of hibernation is unknown for this species, so effects of soil disturbance or fire management during the period from August through April cannot be predicted. Tree planting has been implicated as a factor in habitat loss for *S. indiana* (Schweitzer, 1989).

Management

Management methods that promote lupine growth and enhance Karner blue habitat may, depending on their timing or intensity, have either positive or negative impacts on other species. It should be recognized that nonmanagement is also a management decision. Since research on management of barrens associated species is incomplete, definitive recommendations cannot be made upon current knowledge. However, it is hoped that this information can help lead to an informed land management process based on the best available data.

Under an adaptive management approach (Baskerville, 1985) clear goals are set, pre- and post-treatment observations made, and management practices modified based upon documented results. Best management practices would suggest first surveying recovery sites for these lepidoptera. Barrens dependent lepidoptera present a broad range of response to management so that their particular needs should be incorporated into the goals of site specific recovery plans. While there is no legal requirement to manage for these associated species, understanding something about their biology may allow the land manager to avoid any incremental costs, and preserve needed habitat for more species.

Because no one management type is favorable to all species, when managing for multiple species it is even more important to divide the site into multiple management plots so as to not include a large portion of a required plant resource in any one plot. Leaving portions undisturbed provides refugia for recolonization for species that may initially suffer high mortality due to management strategies being employed.

Its better for each site to adapt its management to its own particular species and history, rather than blindly follow how other sites are managed . Using different management techniques for similar sites is beneficial because various species differ as to favorable and adverse management types, even among specialists of the same habitat (Swengel and Swengel, 1997). For example, at Swengel's Frosted elfin highway site the ditch may be mowed more than once per year while the power line may not get mowed for several years, providing a gradient of management intensity and shrub transition to the adjoining property (Swengel, 1996c).

Management consistency within a particular site is equally important because the sequential use of different management types may successively eliminate species sensitive to each type (Swengel and Swengel, 1997). In the current fragmented landscape subsets or species assemblages can still be identified and conserved efficiently within the same set of sites.

Barrens management includes strategies ranging from intensive such as prescribed fire, to more moderate such as mowing, haying, thinning, grazing and applying herbicides to doing nothing. Most barrens dependent lepidoptera showed significantly increased numbers associated with less frequent and/or less intrusive managements; however, leaving habitat entirely unmanaged was rarely optimal (Swengel , 1997a). A general discussion of these techniques as they may apply to associated species follows.

Intensive Management

Fire: Fires which open new sites and set back succession have been proposed to have been an integral part of the barrens community. High intensity burns are expected to be needed in areas with closed tree canopies. The thick bark of bur oak makes it more tolerant to fire, while black oak may be top killed with high intensity fire but persists by resprouting and jack pines with thinner bark are less likely to survive fire (Curtis, 1959, Benzie 1977). Examples given by New (1993) of fires benefiting a butterfly were typically infrequent burns that create new habitat patches to be occupied by the butterflies afterward during long fire-free intervals, rather than repeated fires that maintain existing habitat already occupied by the butterfly. Swengel distinguishes between fire management and wildfire effects because significantly more wildfire areas are surrounded by habitat that has been left unburned for much longer than are fire-managed areas where the entire habitat is burned by units on a rotational basis.

Any application of fire is likely to result in mortality of some barrens associated species in the burned areas. Less frequent burning over 6-18 year intervals has been suggested in Karner blue populations to allow young oaks to establish and grow to a size and age resistant to fire (Grigore 1992, Givnish et al. 1988). Where prescribed fire is used it is advisable to avoid burning contiguous plots (the smaller the burn size the better), to avoid relighting skipped areas and to minimize backfires. Also, the use of fire alone may stimulate woody growth by selectively benefiting fire tolerant variations in woody growth (Schlict, 1993).

Seasonality of fire influences plant effects, with late spring burning tending to favor warm season grasses and fall burns favoring cool season grasses (Daubenire, 1968, Collins and Glenn 1988). May fires can be particularly detrimental to lupine feeders by altering lupine phenology and flower abundance as well as resulting in direct egg mortality (Swengel, 1994). Skipper larvae may or may not survive in a spring fire. In both cases the species will survive if enough surrounding refugia are left unburned (Nielsen, 1997). Because there is conflicting research about just how deep and how long lethal fire temperature penetrates the soil, refugia should always be preserved.

Swengel (1995) identifies four factors affecting response of prairie butterflies to fire including: (1) habitat niche breadth: species with broad habitat niches are more widespread and more likely to have source populations within dispersal distance for recolonization; (2) voltinism: multivoltine species have more generations in which to recover between fires; (3) location during fire: resident species are vulnerable to fire unless their location (e.g. underground) protects them (cf. McClure, 1981) and (4) vagility: species with a greater dispersal tendency can reoccupy burned sites more quickly.

Karner blues, which have a larval host that benefits from fire (Grigore and Tramer, 1996) appear relatively tolerant of management and of burning, despite apparently high mortality of immatures during fire (Swengel 1995, Swengel and Swengel 1996). According to Swengel (1995), "skipper after skipper we've found experience BOTH short- and long-term declines at fire-managed sites." Fewer, smaller and more restricted lepidoptera populations generally recover slower (if at all) from fire (Swengel, 1995). She found areas burned by a single wildfire 4-18 years ago produced results strongly contrasting with and much more favorable than prescribed burning for the Frosted elfin, Cobweb skipper, Gorgone checkerspot and Leonard's skippers (1997a).

Moderate Management

Mowing/Haying: Areas managed with late-season mowing and with only part of the habitat cut each year appear to benefit a number of species according to Swengel's observations (1994). Most of these barrens dependent species showed significant increases in numbers associated with less frequent and/or less intrusive management. In contrast to fire management, unintensive management supported relatively dense populations of specialist butterflies (Swengel and Swengel, 1997). Mowing and haying are superior for spring flowers to burning which favors native grasses that shade and choke out spring flowers.

Timing and application of mowing management should be considered. For Karner blues the optimal time to mow is mid to late October when overwintering eggs are present and are laid less than 4" from the soil. While it may be efficient to cut or mow before plants translocate winter stores to roots (mid-June through August), species affected should be considered to make sure they are not in a vulnerable life stage. For example, mowing is best done to benefit Frosted elfins long after lupines finished seeding and the larvae have pupated and are presumably lying well

below the mowers blade. The maximum frequency should be once per year to avoid excessive plant damage. Its best that only a portion of the habitat be mowed at a time. Slash and clippings after mowing or cutting should be spread on non-habitat areas.

In some cases medium to more severe intensities of mechanical site preparation are needed to encourage Karner blue plant resources while controlling competing species such as Pennsylvania sedge (*Carex pennsylvanica).*

Grazing: Grazing is more gradual than mowing/haying. Some have proposed that the presence or absence of grazers has a lot to do with control of woody growth. Native grazers which have co-evolved with the plants in these habitats may be preferable to domestic grazers but their feeding preferences should be considered in relation to species present at that site. Experimentation with buffalo grazing is being contemplated in Wood County. Due to the size of most sites grazing should only be used occasionally and for brief periods.

Herbicides: Application of herbicides directly to competing woody vegetation through basal sprays, stump treatments, hack-n-squirt methods, etc. is expected to minimize contact of herbicide with Karner blue plant resources and is generally considered the safest method. Herbicides reducing competition to understory vegetation are expected to result in an increase in the abundance of species present and in species diversity, although increases may only last a few years. Surveys are necessary prior to herbicide release studies. Herbicides may be required for aggressive species and species that create underground suckers from mechanical treatments and should be considered for difficult species such as sumac and black locust.

It should be noted that pesticides can be harmful to many species of lepidoptera. For example, Btk used in control of Gypsy moth is known to kill Karner larvae in laboratory settings and it is expected that applications in Karner blue occupied areas will result in significant Karner mortality and negatively impact non-target butterfly and moth species (Papp, 1996). The U.S. Fish and Wildlife Service recommends that use of Bt and Btk within one-half mile of Karner blue occupied habitat be prohibited (Lane, 1997). However, shade is also lost from gypsy moth defoliated trees (Papp, 1996; Lane 1997). Wisconsin's Department of Agriculture, Trade and Consumer Protection, which is an HCP partner, has drafted guidelines for pesticide use in Karner blue habitat.

Thinning/cutting: Tree cutting or girdling can be used to begin restoring a forested area to more open barrens to allow sufficient light for needed understory vegetation. Red pine stands may require a wider spacing than jack pine to permit sufficient light to reach the forest floor and allow lupine or other host plants to persist. Openings must be large enough to permit flowering of lupine and nectar plants. The size of the opening needed to permit lupine flowering will vary with the tree species, age of trees, and other factors, but is expected to occur at 1.5 to 2 times the average height of surrounding trees or with an average canopy cover of between 40% and 60% (Maxwell and Givnish, 1993). Removal of larger trees should be done in the winter with frozen

ground and snow cover in order to protect the suppressed understory species. Setback of woody species can be maximized by cutting and recutting sprouts more than once per year as well as recutting in successive years.

Short-term Nonmanagement

While fire suppression and habitat fragmentation have increased the need for overt management, management may not always be appropriate. In the long-term, an early successional community requires disturbance, however some sites such as hot sandy sites may change very little from year to year and drier soils require less frequent fires. In light of limited information on these sites little or no management may be best in the short-term until more information is known. Some species such as Dusted skippers and Gorgone checkerspots have been found to be adversely affected by even non-intrusive managements. Swengel found the Cobweb skipper and Leonard's skipper rather intolerant of any active management type (1997a).

Additional Considerations

It would be beneficial to broaden research focused on Karner blues to include the species treated here as well as other barrens associated species. Basic life history questions integral to management (such as whether Frosted elfins pupate in leaf litter or underground in Wisconsin) need to be resolved. Observations and photographs of nectaring, mating, ovipositions etc. especially as part of planned studies are very useful. Collecting is an effective way to document/support distribution, life history, behavioral, ecological and evolutionary/taxonomic studies. To reliably evaluate if the lepidoptera component of an ecosystem is being preserved requires a voucher material baseline on species that occur there. Extensive species inventory collections from specialized habitats are needed to improve our understanding of what species are dependent on these habitats. Numbers of specimens collected are generally negligible in terms of insect population levels but these vouchers contribute significantly to identification of quality habitat and our understanding of the barrens ecosystem. Emphasis and concern should not be misplaced on individual organisms with regard to reasonable collecting or experimentation when considering intensive management and conservation options that may significantly impact populations.

This report includes only one moth species as moth taxa are relatively poorly known compared to butterflies in terms of general biology, habitat association and response to management practices. In Ferge's (1997) opinion, "we hardly have enough data on common forest habitats and various disturbed areas to use as a baseline to evaluate the uniqueness of the barrens or prairie moth fauna." In order to provide HCP partners with some currently available information, Kons and Borth prepared a "Preliminary Wisconsin List of Barrens and Dry Prairie Associated Moths" (1996) based on consideration of well over 15,000 moth records from a diverse array of general and specialized habitats and published larval hosts. While additional information will likely

warrant species' additions or deletions, this list is intended to lead to better informed decisions for evaluating habitat quality and site management than species' inventories alone. For example, it cites lead plant, which occurs in some Karner blue habitat, as a critical larval host for several moth species which are highly sensitive to fire (Borth and Barina, 1991).

Concluding Remarks

There is a need to preserve high quality barrens areas of sufficient size that they cannot be entirely consumed by a single fire. We should not try to create Karner blue zoos and wildflower gardens when dealing with large tracts of land, but rather something resembling natural habitat in which the Karner blues and associated species occur in their natural state with as little direct management as possible and on sufficient acreage (Schweitzer, 1994b). Small patches of habitat supporting specialized lepidoptera also have value.

The Karner blue's protective umbrella has many holes with regard to other barrens associated species. However, by taking an ecosystem approach, which also incorporates the biological requirements of other lepidoptera, a land manager can maintain healthy and diverse populations of other barrens associated species in addition to fulfilling legal obligations to protect the Karner blue.

Color Photos

The original report by R.J. Borth and others included one page with nine color photographs. These pictures are not reproduced here due to difficulties associated with printing and publishing.

Species depicted included *Erynnis martialis, Erynnis persius, Incisalia hanrici, Chlosyne gorgone, Atrytonopsis hianna, Schinia indiana, Hesperia leonardus, Hesperia metea,* and *Incisalia irus*.

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